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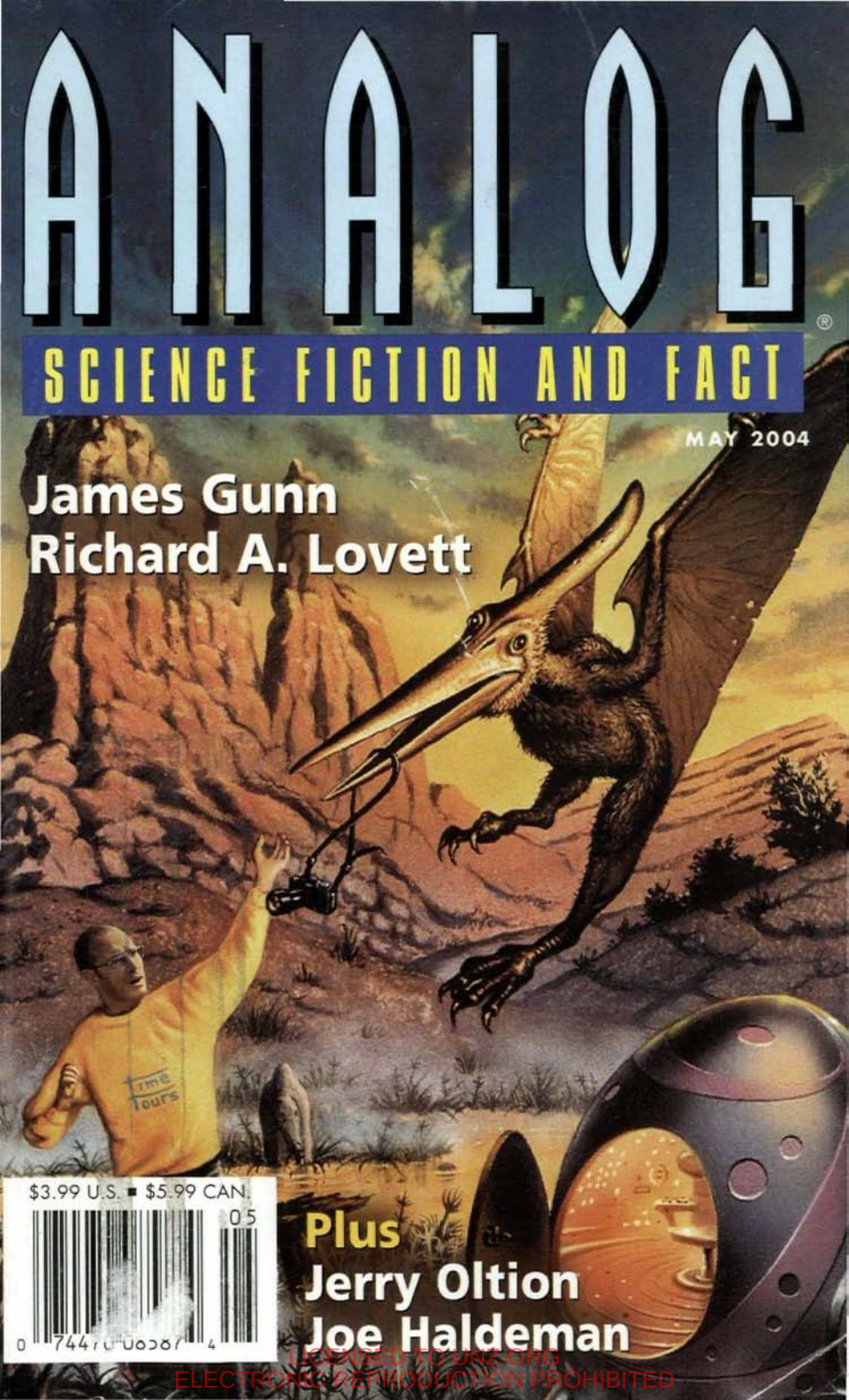

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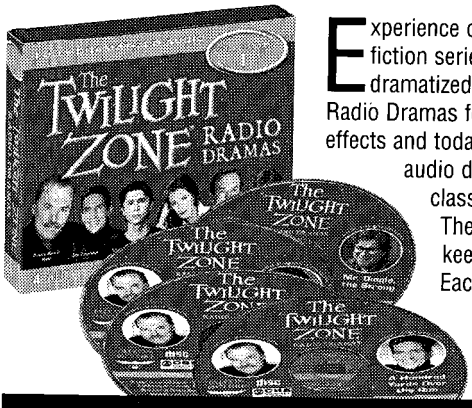

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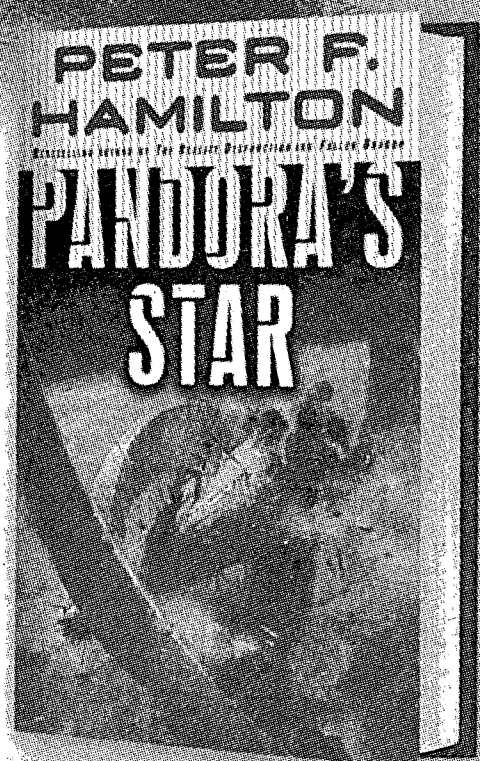

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SCIENCE FICTION AND FACT

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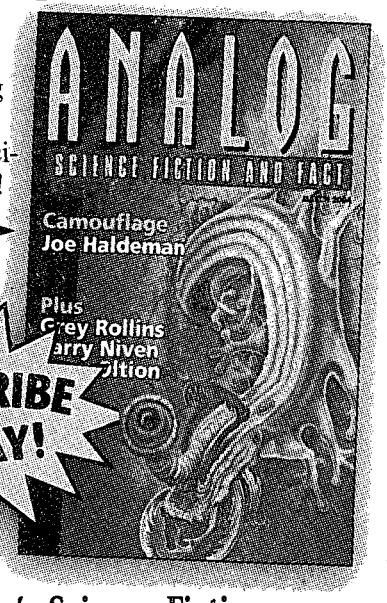

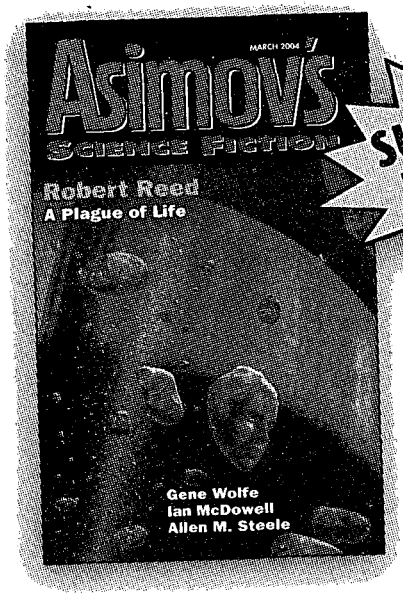

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EDITORIAL Stanley Schmidt

DO ALL ROADS LEAD?

At the 2003 World Science Fiction Convention in Toronto, I participated in a panel called "Design a Truly Alien Alien," ably moderated by the always imaginative and stimulating Ctein. The capsule description in the pocket program said, "In science fiction TV, aliens typically resemble humans with rubber face masks and behavioral patterns less bizarre than some members of your own family. In extreme cases, we may be presented with creatures that, while not human, are clearly inspired by terrestrial life-forms such as insects or octopi. Yet it is statistically ludicrous that actual aliens would be so utterly familiar. . . ."

Well, yes and no—but how much of each?

First of all, it's not a purely statistical process. The form and functioning of organisms is not determined purely by chance. True, they evolve by random mutation of individual traits followed by natural selection of the ones best able to survive in their environment; but the result is that the ones that do survive are ones that function effectively in that environment. Which ones those are is determined by the same kinds of engineering principles that govern the design of any kind of machinery. L. Sprague de Camp wrote much more about this in his two-part article "Design for Life" (*Astounding*, May-June 1939); and I in my book *Aliens and Alien Societies* (Writer's Digest Books, 1996 [especially Chapter 5, "Engineering Organisms"]). I don't have room to repeat all those arguments here, but I will say that de Camp made a good case for believing that intelligent beings evolved in similar environments on an Earthlike planet are likely to look at least vaguely humanoid. He also did a good analysis of why practically all of the large swimmers on Earth are streamlined in similar ways, divisible into three subtypes depending on exactly *how* they swim.

It's true that too many science-fictional aliens (especially in movies and television) are "humans in rubber suits" or impractical combinations of traits cobbled together from unrelated terrestrial animals. Nevertheless, it seems quite safe to say that you will *very* seldom encounter big swimmers in the form of sharp-edged cubes—anywhere. Nor will you find something that looks like a fish or an octopus living in a desert. That kind of design just doesn't work for that job.

The similarity of swimmers to which de Camp devoted such attention is one example of "convergent evolution," in which similar environmental problems independently lead to similar biological solutions in different places. Examples abound on Earth, and the similarities sometimes go even further than you might expect. The South American birds called jacamars, for example, look and act very much like the African bee-eaters, even though the two families are not closely related. Given that they both live in tropical climates and make their livings by catching flying insects and battering them to death against branches, it's probably not surprising that

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they're similar in size and shape. But why should their color schemes be so similar? I don't know.

When, on that panel, I mentioned the many examples of convergent evolution on Earth, my esteemed colleague Ctein expressed skepticism about how much that implied about forms life might take on other worlds. After all, the same environment here can include spruce trees, club mosses, cardinals, otters, and moose. Does that not prove that many different kinds of organisms can evolve in the same kind of environment? And does that not imply that completely different ones might evolve in a similar environment elsewhere?

The answer to the first question is clearly yes, in a coarse sort of way—but not if you look closer. Spruce trees, club mosses, cardinals, otters, and moose all occupy different *parts* of the environment, or "microenvironments." In fact, each of them is part of the environment for all the others. The whole collection of organisms in a region, and the ways they interact, constitute an ecosystem, and what I have called "microenvironments" are more commonly called ecological niches. Both cardinals and otters, for example, are parts of a common Canadian type of ecosystem; but a cardinal is not at all suited to functioning in the part of that environment, the niche, occupied by the otter—or vice versa. If anything else ever tried to occupy the otter's niche, the otter has long since outcompeted it to extinction.

If you go to other parts of the planet at similar latitudes and with similar climates, you may find different species of conifers or lycopodia or seed-eating birds, but you'll find *similar* species making up an ecosystem overall so much like the other that an untrained observer may not notice the difference. Boreal forests look and feel quite similar in widely separated places all around the globe, even if they're made up of largely different species. So do tropical rain forests. So do coral reefs.

Etc. It can easily make one suspect that while many different kinds of organisms can evolve in a particular combination of terrain and climate, that combination will strongly tend to produce *sets* of such organisms that have large numbers of obvious similarities. But must it always be the *same* kind of set?

Even on Earth we can find examples to suggest that it doesn't. Australia has been isolated from all the other continents longer than they have been separated from each other, and that isolation has allowed parts of its evolution to proceed in ways notably different from the ones that occurred elsewhere. The best-known example is the marsupials, a group of mammals using a significantly different form of reproduction than the placental mammals that predominate elsewhere (though it can be viewed as a variation on the same theme). Australian

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marsupials have branched out to exploit practically all the ecological niches available on their home continent, and some of those have developed different solutions to similar problems than their placental analogs on other continents. Where Europe, Asia, Africa, and the Americas have deer and/or antelope in the "large herbivore" department, Australia has kangaroos and wallabies. Deer and antelope run; kangaroos and wallabies hop, even in similar environments. So we know that solutions at least that diverse can occur.

On the other hand, hopping isn't all *that* different from running. Both categories of critters use four legs, and choosing one mode or the other is principally a matter of changing the details—such as size and proportions—of bones and muscles. For that matter, similar changes, only more so, can change legs to arms, wings, fins, or flippers. How about more fundamentally different solutions to the "getting around" problem—like wheels? They work quite well, in suitable environments, so why don't we see them (at least in largish, multicellular animals) on Earth? Probably the more important reason is that evolution works by single modifications of things that have already evolved. Legs, wings, and flippers are similar enough in their fundamental structures that it's relatively easy to turn one of them into one of the others by a series of such incremental changes. It's much harder to get from any of them to a wheel and axle. The structure is too fundamentally different; changing one to the other would require several *simultaneous*—and drastic—changes.

But what if you *started* from a fundamentally different point? All the examples we can point to so far are things that evolved on Earth and are based on DNA. That doesn't necessarily mean that that's the only way it can happen anywhere else. If the first organisms on a different planet made some different "choices" than the ones that were made here on Earth, subsequent evolution might have led to a whole cascade of approaches—and organisms—quite different from the ones that developed here. Such a thing conceivably may have even tried to happen here, but the version with the head start overwhelmed the upstart and squelched it before it could amount to much. Willy Ley said some decades ago that, "A prerequisite for life to start on a planet is that there be no al-

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ready developed life forms there"—because if there are, they'll be very hard for new beginners to compete with. One might imagine that life could start independently in two separate *parts* of a planet, if the first set hasn't already spread to the second point of origin, but Ley's point is basically sound. If there ever were fundamentally different approaches to life here, they were overwhelmed long before we got to see the results.

But different approaches may have happened—or may still happen in the future—on other planets. Biologist and writer Joan Slonczewski imagined such a situation in "Microbe" (*Analog*, August 1995): an ecosystem based on *triple* (rather than double) helices of DNA, in which pavement-like plants co-evolved with wheel-like animals.

So quite different kinds of organisms and ecosystems may indeed have evolved on other worlds—even under conditions otherwise similar to ones found on Earth. All it takes is a different starting point than we had on Earth, and a logical progression of subsequent evolution. The possibilities aren't quite limitless—any organism anywhere must be a valid engineering solution to the problems posed by its environment—but they're almost certainly wider than the range we see on our little planet.

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Elixir

James Gunn

There are things that most people would like, and getting them can involve strange collaborations. . . .

. . . We thank with brief thanksgiving
Whatever gods may be . . .
—Algernon Charles Swinburne

The mouse lay dead upon the stainless-steel table, its dark, empty eyes staring out blindly at a world that for it and its siblings had been set about by bars into which nectar and ambrosia had fallen from the heavens and a hand had descended from time to time to lift and stroke and inject foreign substances. But in what significant way did that differ from the experience of the men and women who used it in their experiments?

The laboratory was shiny and sterile and neat, windowless and isolated. It was not the movie laboratory of test tubes and smoking retorts and laddering electricity. This was a biological research laboratory in a modern hospital, and it was fashioned from glass and stainless steel. Here and there pieces of equipment rested on scrubbed tables: microscopes and autoclaves and centrifuges, refrigerators and petri dishes and computers, all carefully cleaned each morning and evening with antiseptic solutions. Ultraviolet fluorescent bulbs periodically added their invisible radiation, and the single entrance was an airlock with negative pressure.

In the midst of the latest symbols of contemporary science, Dr. Russell Pearce looked like an anomaly—aging, contaminated with various kinds of microorganisms, rumpled, and dejected. His latest effort to synthesize the *elixir vitae* had failed. At first the synthetic blood protein had seemed promising; some of the mice to whom test substances had been administered had grown more active and the ones who sickened or aged were discovered to have received double-blind placebos. But now the proof of failure lay in front of him, a mouse dead of senescence, whose numbered tag matched a number assigned to those that had received what

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Pearce had hoped would be the elixir. The mouse was, in fact, the last of the group that had been administered the latest cure-all, the miracle fluid that would heal the sick, restore the elderly, and extend the life span indefinitely.

Pearce sighed, entered the results in his computer, and stared at the inscrutable screen as blindly as the mouse in front of him. It was a long road he had started down fifty years before, when an unemployed wanderer had sold 500 cc of his blood and that magic red fluid had rejuvenated an aging billionaire. But the restoration was only temporary, lasting as long as the gamma globulins had conferred their immunities, thirty to forty days. For fifty years now Pearce had been searching for the secret to immortality, just as, he was sure, aging men of wealth and power had been searching for Marshall Cartwright and his children.

The Executive Vice Chancellor's office occupied a prime corner location of the Medical Center. Windows on both sides admitted the autumn sunlight and a view to the south and west toward the green suburbs, not north and east toward the carcinogenic inner city. The room looked like a seventeenth-century English library with pale wood shelves and a massive desk, and, in fact, had been purchased in entirety from a British estate, dismantled, and rebuilt in this upstart Midwestern city. It was the tribute youthful vigor pays to decadent tradition.

The Vice Chancellor seemed young and inexperienced, obviously uncomfortable talking to Pearce and what had to be communicated to him, but Pearce waited with the patience of his years. Then she swung her chair away from the windows and said, "How long have you been working at this Ponce de Leon project?"

"Fifty years," Pearce said.

"Isn't that a bit long to pursue a will of the wisp?"

"It's one of the two basic dreams of humanity: unlimited wealth and immortality."

"Even Ponce de Leon finally gave up."

"He was killed by Indians before he had the chance."

"The transmutation of base metals into gold and the concoction of the elixir of life," she said. Her smooth forehead furrowed. "But the alchemists abandoned their futile quests when the physical sciences proved their impossibility."

"Not exactly," Pearce said. "The alchemists transmuted themselves into chemists and physicists, and they learned that you can change base metals into gold, but it costs too much. And some of the alchemists became biologists, and they learned that the lifespan can be extended, but unless you reduce the birthrate you get overpopulation, pollution, starvation, and disease."

"You have an interest in the history of medicine, as well," she said. Clearly there was something on her mind other than simply getting acquainted with the faculty. "I understand now why you're the senior geriatrician on the staff." She looked down at the folder open on her desk. "Indeed, the senior physician at the Medical Center."

Pearce smiled ruefully. "The trick of being senior is to outlast everybody else. I used to be a young geriatrician. Now I'm a subject for my own specialty."

"That's why it's so difficult to tell you what I've got to say." Color rose in her cheeks. "You're a legend. You've done so much for this hospital, both in the classroom and the hospital."

Pearce waited, although it was clear what she had on her mind. He wasn't going to make it any easier.

She looked embarrassed. "The funds for your research have not been renewed."

"The National Research Institute has decided to discontinue its funding?"

She nodded. "What is the National Research Institute, by the way? It's new to me."

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"In spite of the 'National' in its name, it is a private philanthropy that sponsors research into the causes and treatments for aging. I don't know much more than that. They came to me, many years ago, and my only contact with them has been my annual report and request for renewal. The Institute has always seemed eager to receive the report, and up to now to renew the grant."

"No longer, apparently. We received the termination letter today."

Pearce looked thoughtful. "And the last experiment ended in failure yesterday. That's odd."

"What's odd?"

"The coincidence. It's been my experience that most coincidences are not coincidences at all."

"And most so-called conspiracies turn out to be coincidences," she said.

Pearce laughed. "True, and no doubt this is one of them."

"In any case, the termination came at the customary time, in response to our application."

"What reason did they give?"

"No reason. They just didn't renew. Maybe you can get results in the few months that are left on the grant. Or maybe you can persuade the Institute to renew."

Pearce smiled. "After fifty years? Well, I can understand their impatience. Thanks, anyway, Vice Chancellor."

"Please call me 'Julia,'" she said. "And you forgot a third basic dream of humanity."

"And what is that?"

"Love," she said and color rose in her cheeks. She colored beautifully. It was a trait that might yet interfere with her administrative duties.

"The alchemists left that to the magicians," Pearce said. "Maybe because it wasn't basic. Or maybe they thought they could buy love with unlimited wealth."

"Or the promise of immortality," she added.

He got up to leave but she stopped him at the door. "Fifty years," she said. "You must be—"

"Ninety," he said.

"You don't look more than fifty," she said. "If I didn't know better, I might suspect that you have found the elixir and kept it to yourself."

"Good genes," he said, "and the power of positive thinking."

And then, as the solid wooden door closed behind him, he stood in the hall, with its special hospital odor that spoke to him of the practice of medicine more than the stethoscope and the scalpel themselves, and wondered what he was going to do now.

He was late for his hospital rounds, but the summons from Julia Hudson had been urgent. Now he wondered about the hurry to inform him of termination and why it had come through the Executive Vice Chancellor, in person, rather than through customary channels. Maybe, after all these years, the Regents were trying to get him to resign, which might explain why Hudson hadn't offered to finance his research out of the Center's own funds. Or maybe Hudson had wanted to break the bad news in person, to soften the blow, and he was being paranoid again.

But that was soon driven from his mind by the patients waiting for him in room after room of the hospital wing devoted to geriatrics. As the population had aged, the wing had grown until now it occupied an area as large as that of the next two specialties combined.

His group of senior medical students had preceded him, but his resident physician and research assistant, Tom Barnett, was perfectly capable of supervising them and of replacing him, as, Pearce was sure, Barnett hoped some day to do. One problem with longevity, particularly longevity in career or profession, was the difficulty of the young in getting on: the road ahead was clogged with slow or stalled vehicles. Death was evolution's way of improving

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the species, and if death is delayed the basic processes of life are frustrated.

As one of the roadblocks on the highway of progress, Pearce felt a bit ashamed of the way he clung to his practice and his research. But he had never married, his work gave meaning to life, and he didn't *feel* ninety years old. In fact, inside he felt about the same age as when he had stared down at a rejuvenated Leroy Weaver. He was as good as any physician on the staff, he knew—indeed, with the accumulated clinical experience of more than fifty years, he felt he was a good deal better. And his skills in the laboratory were superior to what they had been when he was forty and had been driven there by the miracle of Marshall Cartwright.

Now, as he went from room to room and bed to bed, taking a hand here, feeling a brow there, checking a chart, speaking a cheerful greeting, asking an interested question by name, saying goodbye with feeling, he noted the ages of his patients. There were fewer sixty- or seventy-year-olds among them than there once had been when he was first starting his practice. Now most were in their eighties or nineties and a number of them into their hundreds.

People were living longer, but the diseases and systemic failures they avoided in earlier life left them prey to the degenerative diseases and cancers of old age. You avoid heart failure, and you live long enough to have a cancer metastasize from your prostate; you keep your kidneys and liver working properly, and your brain finally succumbs to stroke or Alzheimer's disease. And the costs of treating the diseases of old age were far greater than the quick and easy deaths of youth or middle years. Even if one included the Acquired Immunity Deficiency diseases. Small wonder the social costs of medical care had soared until today only those were treated who could afford to pay, and the rest were left to their traditional resources: nostrums and faith healers and the few clinics that hospitals such as this one kept open to the public—mostly to the old to use as clinical material for finding cures to the diseases of old age. Some day, Pearce thought, the few who could afford the best of care would become totally dependent upon it, and medicine would turn for its source of vaccines and antibodies and even antibiotics to those who had been denied the benefits of modern medicine.

Pearce could foresee a time when medicine would become a kind of contemporary religion where the common people came to worship, and physicians, indistinguishable from witch doctors shaking their rattles over their patients to drive out demons, would become the priests of a new mythology. Their altar would be an operating table and their communion, a vitamin tablet and an oral antibiotic.

Pearce caught up with his group of students before the end of rounds. The group had grown larger over the years, to match the growth in the geriatrics wing. Geriatrics was a growth industry, and medical students alert to the latest trends invested their time and hopes in an appropriate specialty. Pearce wondered if it had been different when he had made his own choice so many years before, but it was so long ago that his younger self was like a stranger and he could not remember.

He waited at the back of the group, unnoticed, while Barnett had each of them, in turn, prod the patient, poor Mr. Sam Aikens with his chronic nephritis, and jabbed at the physicians-to-be with hard questions, as if trying to trick them into a faulty answer that would allow him to display his erudition and wit, and demonstrate to everyone the necessity of study and of *being right*. It was one way of teaching, and he had been subjected to that in his medical school days, as well as the three-days-on and three-days-off ordeal of residency, but it wasn't his way. A ready answer was not always a right answer, and being quick

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was often inferior to being thorough.

Mr. Aikens was a charity case. Barnett would have treated a paying customer more gently.

Barnett was quick, but his quickness had produced no better results in the elixir synthesis than Pearce's thoroughness. Of course, he thought ruefully, there is little discrimination between failures.

"I'll take over, Dr. Barnett," he said, making his way to the front of the group. He felt the students' relief and sensed the reluctance with which Barnett surrendered his place. He would have to do something for Barnett, he told himself, as he told the students about Mr. Aikens and his life and his family situation, and asked the patient to describe his symptoms. He asked each of them, in turn, to hold Mr. Aikens's wrist and feel his pulse, a function measured better by instruments and recorded on a panel behind the patient's bed, along with other vital signs. And he asked them to feel Mr. Aikens's back gently, to sense his pain, and to try to get inside Mr. Aikens's illness.

"All these devices," he said, sweeping his hand around the room, "are wonderful, but they cannot replace the physician's inner sense and a caring—one might almost say, a curing—touch."

The students reacted differently as they were dismissed for the day, some of them relieved to discover that the practice of medicine had not yet been mechanized, others, uneasy in human relationships, resentful that this old doctor was asking them to do more than memorize the names of the body parts and the various ailments to which they were prone. But Barnett was gone before Pearce could tell him about the outcome of the grant application. When he got back to his office he opened the piece of paper that Mr. Aikens had slipped into his hand when Pearce had held it.

"I need you," the note read. "Come to 3416 East 10th tonight and ask for Marilyn. Destroy this note. We're both in danger."

The address was in an area that once had been middle class but had been sliding down the income slope ever since. The neighborhood was poor but the people within it were not yet hopeless. It lay outside the inner city, but the inner city was metastasizing toward it, and Pearce had been forced to cross oncological arms after leaving the comparative safety of the interstate. He had kept the bulletproof windows of his armored car rolled up and a prayer on his lips to Hephaestus, the god of craftsmen, that his engine had been well and truly made.

The house stood among narrow, two-story residences on narrow lots. Once, no doubt, they had been single-family homes, but now, Pearce suspected, they were carved up into single rooms for multiple families. The computer map had got him this far, but Pearce could not have deduced which house was his destination had he not been able to determine from an old street sign that this was Tenth Street and from an intact house number that he was in the 3400 block. The house just to the west had a "4" and a "1" hanging awry beside it from the edge of the front porch roof, and the one in front of Pearce, a "6." Behind it, in the dusk, loomed the blank wall of a structure built of concrete blocks, either a small factory or a large garage. Beside the house was a lot piled with old iron pipes and littered with rusting construction equipment, and the remains of a small drilling derrick.

What once had been a small front yard had been paved for parking, but the only other vehicle was a rusted hulk from which the wheels had been removed. Pearce would have preferred to pull his car around to the back and out of sight, but the lot was too narrow for a driveway and he had to trust his vehicle to luck and its own defenses.

He stepped out cautiously, his black

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bag in his hand, wondering why he was responding to this anonymous cry for help. It might well be a trap. Physicians had been abducted before by gangs desperate for medical treatment, or for their instruments and drugs. But seldom had a plan been laid to lure a physician into danger, and he did not think Aikens would join any such attempt.

He moved carefully up squeaking wooden stairs, shining a light onto a porch with boards missing like a ghetto-dweller's teeth. The front door was unlocked, and when Pearce pushed it open he noticed that the frame had been splintered, not once but many times, until, no doubt, the residents had surrendered to the inevitable.

The hall was dark. Above, Pearce's light revealed an empty socket; if a bulb had been available, and the electricity had not been cut off long ago, it would have been stolen. Stairs led up from the hall to a landing and a door and then turned to ascend toward a mysterious second floor. To his right was an archway, perhaps to the building's one-time living room, but the arch had been closed by plywood covered with graffiti. The plywood had been painted and repainted in a futile effort to maintain a minimal level of self-respect, but the graffiti showed through like palimpsests of earlier civilizations.

In the middle of the plywood was a hinged panel that served as a door. No name or number on it—anyone who had reason to be there knew who lived within, and anyone else had no good reason to be there. Except himself, he thought, and knocked.

"Come in," a woman's voice said.

He pushed open the panel to find himself blinded by a flashlight. He had a feeling there was a weapon behind it. "Marilyn?" he asked.

The light went out. "You're Dr. Pearce?"

"Yes." Several moments passed before his eyesight returned.

"I'm Marilyn Van Cleve, and I need your help."

He could see now. An oil lamp on an old card table illuminated a woman seated beside it in a large, shabby recliner. She had a flashlight in her lap and an old-fashioned revolver on the table beside the lamp. She was an attractive woman with brown hair cut short and large brown eyes that looked at him warily but unafraid. Her most attractive feature, however, was her health; in the midst of a sea of sickness, she glowed with a well being that made her seem lit from within.

At first glance Pearce thought perhaps she was in her early twenties, but then he looked again at her eyes; they had seen a great deal of human joy and sadness and suffering.

"What kind of help?" he asked.

"You'd better come in and lock the door. It won't hold anybody out, but it would give me time to get my defenses ready," she said calmly.

"Who are you expecting?" he asked.

"You and whoever may be following you."

"No one is following me," Pearce said impatiently. "I ask you once more, what kind of help?"

"I'm pregnant," she said. She stood up. She was a sturdy woman of medium height, and she was, indeed, pregnant, perhaps eight months along or more, Pearce guessed.

He half-turned toward the door. "I'm not an obstetrician. I have delivered only one baby in the last sixty years. What you need is a midwife."

"This is going to be a difficult delivery. I'm going to need more help than a midwife can provide."

"How do you know?"

"I know," she said.

"Then you belong in a hospital. Even if you can't afford it, there is a clinic for indigents. Medical students need the practice."

"They'd draw blood," she said simply.

"They'd do some routine tests, typing in case of the need for transfusions,

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checking for drugs, diseases, anemia—but that's all to the good."

"I can't," she said. "That's why I need you."

He shook his head wearily. "It's been a long day. If you can't use a midwife and you can't go to the hospital, then I can't be of any help to you."

"Don't you understand?" she asked. "I'm a Cartwright."

Pearce's mind slowed, waiting for the implications of Van Cleve's statement to seep through the walls he had built around the image of Marshall Cartwright. After fifty years of searching, he had found his Holy Grail. But she was also in terrible danger—and so was he.

"Clearly you can't go to a hospital," he said. "Even if I were to admit you myself, I couldn't deliver your baby without attracting attention, and attention could be fatal. But why do you think the delivery will be difficult?"

"Cartwright women mature late. I'm fifty years old—"

"The first generation," he said. Cartwright had wasted no time putting into action Pearce's admonition to be fruitful and multiply.

She nodded. "But menopause may have no meaning for us. That remains to be seen. Our organs are tough, however, and the mouth of the uterus may not expand sufficiently to allow the baby to be born. Although I never get sick and injuries heal quickly, and the baby will be the same, it can strangle or suffocate. A Caesarian may be necessary."

Pearce looked around the room. It was not dirty. It had been swept, perhaps even scrubbed, but grime was embedded in the painted walls and the wooden floor and the ancient furniture so deeply that mere soap and water could never reach it. "Not exactly the most sanitary of conditions."

"Not here," she said. "The time is not yet right."

"How far along are you?"

"Nine months." She held up a hand. "But Cartwright babies take a week longer. I got that from my mother. She died when I was only five years old. She never really got over the trauma of my birth. But she told me about my father—a wandering man, she called him, who loved her, she said, but could not stop to take care of her, or me. So I've been on my own since then, and I've done all right, in spite of the knowledge that I had to hide who I was, that people were searching for me. But then"—with a hint of bitterness—"women have always had to hide their superiority from men."

"What about your husband?"

"Him?" She laughed. "He wasn't what you would call a husband, but then I've never had good judgment where men were concerned. My mistake was allowing him to get me pregnant. He disappeared as soon as he found out."

"You never told him about your—special ability?"

"To keep him young forever?" She smiled ruefully; even in rue her smile transformed her face into something approaching what Pearce would call beauty. "You think any man is worth keeping under those terms? Or maybe the habit of concealment ran too deep." She shook her head. "No, I would never tell anybody."

"And you've existed like this?" He waved his hand at the room, implying in that gesture the house, the neighborhood and the neighbors, and all the dirt, disease, degradation, and deprivation that involved.

"It's not what you think," she said. "There are good people here, maybe more than among the medically privileged. But I haven't always been here, even though it is the best place to hide, here where anonymity is a way of life. Sometimes I've allowed myself to rise into the middle class, but I can't remain anywhere very long or the chances of suspicion, or even detection, become too great.

"The difficult part is knowing that I can help people who are sick or injured,

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and realizing that I can't. The moment I let my sympathies take over the stories will start, the scent will be picked up, and the chase will begin. Do you realize—?" She broke off, unable to continue.

Pearce nodded slowly. "I've seen patients that I might be able to save if I used all the medical resources at my command, but I couldn't because the antibiotics were scarce or prohibitively expensive, or because they would not stretch to all who needed them. Deciding who is to live and who is to die—that's called triage."

"It's even worse when you realize that you, yourself, are the fountain of youth."

"And how did you get my name?"

"That's part of the legend, too, part of my inheritance, like a fairy godmother I could call upon in extremity. 'There's Dr. Pearce,' my mother said. 'He's the only one you can trust, but don't call upon him unless you're really in trouble.'" She laughed again, putting her hands on her swollen belly. "I guess that's what I am—a woman in trouble."

He nodded. "It's happened once before, and I tried to help then. I'll help you, of course. But—" he hesitated—"could I take a sample of your blood? I've been trying to synthesize the Cartwright difference ever since I ran across your father, but the original samples ran out long ago and I've had to proceed on guesswork. A sample from you might give me the clue I need."

"Do you think that's wise?"

"To synthesize the elixir?"

She nodded.

"I've thought about it. Knowledge can be used for good or ill, but on the whole more knowledge is better than less. I'll work it out, and then I'll decide what to do with it."

"If the world lets you," she said. "But I can't very well ask your help and then deny your fee." And as he got out his syringe and his bottle of alcohol and sponge, she added, "And what's even more important, you can have the placenta and blood-filled umbilical cord when the baby is born."

He stopped in the midst of inserting the syringe. Of course. Aside from the genes themselves, the placenta and the cord were nourishing, maybe defining the baby. Who knew what magic they might contain?

"But you must promise me not to trust anybody," she said.

"I have assistants," he said.

"Nobody."

He nodded and went about his task. When he was done and the sample was stored in the refrigerated section of his black bag, she said, "I'm going to leave by the back way." She picked up her flashlight and her revolver. "Your pursuers will be here any moment."

She was more paranoid than he. "When do you want me to return?"

She hesitated at a door set into another plywood wall in an archway at the back of the room. "I won't be here. I'll get word to you where and when. Be careful, Dr. Pearce. The world is more treacherous than even you suspect." And she was gone.

The world had turned dark by the time Pearce emerged from the house. Night belonged to the citizens, hiding their blemishes, concealing their movements, masking their intentions. Pearce played his light around the porch, throughout the paved yard, and around his car. Everything seemed as empty and untouched as when he had arrived, but a feeling of danger jangled at his nerves. He shrugged his shoulders and essayed a chuckle. Van Cleve had infected him with her paranoia.

And then, as he picked his way down the stairs and moved toward his car, something monstrous loomed up behind him and he turned to splash his light upon a ragged, hulking, unshaven creature with a club in its hand raised to strike. It was so nightmarish, so traditional in its attitude, that he almost laughed.

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He didn't get the chance. A voice from the street shouted, "Stay where you are! Don't move!" But as Pearce turned toward the voice, the figure behind him twisted away. A laser beam hissed through the night, and a voice cried out, but when he turned back the creature was gone.

"Who's there?" he called out, although he thought he had recognized the voice.

"Dr. Pearce," a voice said, as it moved toward him. "Are you all right?"

When a figure came into the light, Pearce saw who it was. "Tom," he said. "What are you doing here?" He thought briefly of Van Cleve's confidence that he was being followed before he dismissed it. "Not that I'm not glad you showed up."

"I happened to be passing the monitoring station as I was leaving," Tom Barnett said, "and your telltale showed your car in this dangerous part of town. I thought maybe you'd been hijacked or kidnapped, so I reported to the police and thought I'd better start immediately. But what are you doing here?"

That was it, of course. The computerized map system automatically reported its location. No one needed to follow him. Even if he had thought of that, and had believed the note's warning of danger, how could he have made his way here on foot, and how could he have known it was wise to do so?

"I'm one of the few remaining physicians who still make house calls," Pearce said lightly. "A habit from the old days I find hard to break." He thought quickly: Trust nobody, Van Cleve had insisted. "I got a message—someone just pushed it into my hand." Might as well stick as closely to the truth as possible, he thought, and electronic messages left trails that could be checked. "I thought it was somebody I ought to know, but by the time I got here I knew there was something wrong."

"You've got to stop this, Russ," Barnett said. His voice was husky with concern. "You're getting up in years, and you're too valuable, and there may be people out to get you."

"Who could be out to get me?" Pearce scoffed. "But you're right: these are dangerous times. You said the police have been called? We'd better cancel that alarm before we have to answer a lot of questions, and get back to the hospital compound before my attacker returns with his friends."

"You lead the way, and I'll follow behind," Barnett said.

Pearce nodded and swung his bag with its priceless contents into the front seat beside him, where it wouldn't be far from him, and pulled his car into the street where his headlights splashed across Barnett's car. It was newer and more heavily armored than his, and Pearce wondered how Barnett could afford it on a resident's salary. Perhaps he had inherited money or had his funds supplemented by his family, or a patron protecting his avenue of supply.

They retraced Pearce's route, but this time with the comfort of convoy and Barnett's laser gun. As Pearce drove, he was swept by a wave of weariness. The day had been long and filled with energy-consuming events, and he felt every one of his ninety years. A great sense of relief washed over him when he pulled through the Medical Center's guarded gates and into the living compound where nothing but an all-out attack by a fully equipped military unit could threaten him.

And yet, as he said good night to Barnett and thanked him once more for saving him from robbery or even death, he could not help but wonder why the police had never arrived.

Early morning hospital corridors echo footsteps like late night sidewalks, and Pearce pushed away his uneasy feeling of being followed as he made his way to his laboratory with his tube of irreplaceable fluid still locked in his black bag. His sleep had been more than usually

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disturbed by the awakenings of the elderly, the swirling memories, the bladder pressures, the terminal insomnia, and at last he had surrendered to his impatience to be up and about his work. Soon the corridors would be thronging with breakfast wagons and hospital gurneys headed for morning tests and surgeries, nurses bustling about their innumerable tasks, and the hospital once more engaged in its epic struggle between sickness and good health, between death and life. But he reached the laboratory in the bowels of the basement without seeing more than a couple of night-shift nurses yawning at their stations.

Pearce poured half the blood sample into a tube that he sealed and returned to his black bag. The other half he poured into a density gradient tube, diluted it with cesium chloride, and inserted it into the ultracentrifuge. He set the dial at 100 and turned it on. After a few minutes, he turned off the machine and removed the test tube. He held the tube in the ultraviolet light case. DNA molecules were the heaviest part of the blood and the bottom of the tube was the darkest. He poured the top 90 percent of the fluid into another tube that he put into his black bag.

He should turn this process over to a laboratory that specialized in these procedures, he knew, but he could trust none of them. That wasn't Van Cleve's paranoia; it was simple realism. The price of liberty might be eternal vigilance, but the price of immortality was eternal suspicion.

Tom Barnett came into the laboratory while he was cleaning and sterilizing the tubes, and Pearce told him the grant renewal application had been rejected. "We're out of business, Tom," he said. "You might as well use your remaining assistantship working on something that will have a pay-off."

"What about you?" Barnett asked.

"I'm going to keep tinkering," Pearce said. "They'll probably reclaim the space, and the live subjects probably are too expensive, but maybe I can hang on to the equipment. No use starting a new line of research at my age."

"I'd like to help," Barnett said, "even if I can't be paid."

"I couldn't allow that. You've got a career ahead of you. Go on with you," Pearce said roughly. "Get about it. I'll give you glowing references as a clinician and a researcher."

Barnett left reluctantly, and Pearce returned to his labors.

He removed from the refrigerator a flat silica gel in a sterile plastic wrapping, placed it between two electrical contacts that passed a current across the gel, and carefully poured what was left in the density gradient tube over the gel. A few minutes later he put the gel under the ultraviolet light and with a sterile, sharp-bladed knife scraped from the top of it the darkest rungs of the ladder. He put them into a receptor tube and removed the gel remnants through electrophoresis. What he had left, if he was lucky, was DNA.

He put the rest of the gel into his black bag for later analysis of the remaining blood fractions, but for now he was going to focus on DNA. Whatever special properties were possessed by the Cartwright blood had to be traceable to the DNA and, what was even more important, reproducible.

Pearce put his DNA sample into an aluminum box stuffed with test tubes. He added some primer, polymerase, and nucleotides. The PCR machine would do the rest, applying heat to the DNA, breaking the bonds that hold the strands of the double helix together. When the temperature was reduced, the primers would attach themselves to either end of the strip. Polymerase, the magical substance, would trigger the formation of new DNA strands from the nucleotides. Then the process would begin over again, with the PCR machine raising the temperature to separate the strands of the DNA molecules that now

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had doubled in number.

It was like a chain reaction, each raising and lowering of the temperature creating twice as many strands of DNA as had existed before. The process was exponential. That was why it was called a polymerase chain reaction. Within a few hours Pearce would have a billion copies, and a supply of DNA that he could separate into fragments with enzymes and then test each fragment on a separate sample of tissue cells.

The process had just begun, but at least it had begun. He felt a curious sense of elation that he had not felt for more years than he could remember. It made him feel youthful again. He never felt truly old. He always felt forty inside, that age at which his internal calendar had stopped when the most important event of his life had happened, but his body was less flexible, his muscles didn't recover as quickly from exertion, and he felt pains where once had been nothing but silky articulation. And yet he had the feeling that aging was a state of mind. If there was such a thing as psychosomatic illness, why couldn't there be such a thing as psychosomatic wellness? It would bear thinking about.

He had been so busy with his tasks that he was startled to turn around and find someone in the laboratory with him. It was the Executive Vice Chancellor, Julia Hudson, and she was looking at him with an intensity that first startled and then alarmed him.

"How long have you been standing there?" Pearce asked.

"Only a minute or two. Part of my tour of the Center, you know," she said, answering a question he had not yet asked. "And I wanted to see the Project in action." Her voice capitalized the Project, as if to concede it the importance that he himself would place on it.

But he felt as if she were looking at the space occupied by the laboratory and the equipment it housed as assets to be used for better purposes.

"This is where it happens," he said. "Or doesn't happen. The search for the *elixir vitae*, the rejuvenation factor."

"I hate to see you wasting your time searching for a substance that doesn't exist."

"And the Center's funds?"

She nodded acknowledgement. "That's part of my job, to weigh priorities against resources. The issue is immortality, and nobody lives forever."

"Except the Cartwrights."

"That's mythology, like Santa Claus and the Easter Bunny."

"I have good reason to believe it isn't," Pearce said. "In fact I once was in possession of some of that magical Cartwright blood."

She looked surprised, perhaps even astonished. She was an attractive woman, Pearce had time to think—and even to surprise himself with the thought—with dark lustrous hair, blue eyes, a shapely face, and lips that many young men must have longed to stop with theirs.

"So that's why you have been so persistent," she said. "You're the doctor who treated Leroy Weaver."

"All that has been expunged from the record and is best forgotten," Pearce said. "You can imagine what my life would be like, and how much work I would get done, if it were general knowledge."

"And your research, then—"

"Has been an effort to replicate the properties of Marshall Cartwright's blood. I've always thought the rejuvenating factor must be associated with the gamma globulins, and I have been analyzing Cartwright's DNA ever since, but I had so little to start with, and what I had was diluted and mixed with Weaver's blood and the blood of my laboratory animals, and possibly corrupted, and DNA research then was relatively primitive and undiscriminating—"

"Then it is a will-of-the-wisp."

"The will of the wisp isn't an illusion, you know. It's swamp gas, methane,

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spontaneously ignited. It can be found and identified. This will of the wisp exists, and it, too, can be found and identified, and maybe synthesized."

Her eyes were alive now with the zeal of the quest. "If only a Cartwright would reveal himself, allow himself to be studied. The synthesis could be accomplished in a matter of a few years."

"Now you believe," Pearce said. "But what you propose is impossible. How long do you think a Cartwright would last in a world increasingly obsessed with the fear of dying?"

"But if the *elixir vitae* were synthesized the pressure would be off, the Cartwrights no longer would be the Holy Grail—"

"If—if—so many ifs. The only one certainty is that if they don't reveal themselves they may survive and so may the human species. And therefore my research blunders on."

Her gaze moved around the laboratory, with its gleaming surfaces and functional shapes, with an expression that resembled wistfulness. "I would like to help."

"How?" he asked.

She raised a hand in supplication. "In person, I mean. Research is so neat, so definitive—so much better than the equivocal, messy business of administration. I always loved the laboratory, and I wish I could get back to it. Maybe I could steal a few minutes a day, just to lend a hand?"

"Of course," he said, not committing himself to anything. It was a bit of a coincidence, he thought, that she had showed up just as he was working on the Van Cleve sample. "Any time."

"Have you thought," she asked, "that the rejuvenation factor might be related to the stem cells?"

He paused to reflect. "That's a good idea. I'll think about it. One thing I have begun to suspect over the years is that the phenomenon is more complex than I thought. The Cartwright mutation may combine several improvements, and the stem cells might be one of them."

"Meanwhile," she said, "I'll see that you keep your laboratory and your equipment, even when the grant runs out. And minimal biological supplies if we can camouflage them as clinical. No salaries, I'm afraid," she added apologetically.

"I'll be grateful for whatever you can do," he said and was musing about stem cells as she was turning toward the door. As soon as she was gone he changed the code on the entry panel and added the security that he had never before thought was necessary, his palm print.

The next few days he could steal only an hour or two away from his hospital rounds and teaching duties to check the results in the laboratory. He had nurtured human cell cultures and treated each with a different fragment of DNA that he had separated with enzymes. He had locked them into a machine that periodically washed away the waste byproducts and added fresh nourishment.

Each time he entered the laboratory, however, he had the feeling that someone had been there in his absence. Everything was as he had left it, nothing ever was out of place, but he could not shake the conviction that, in spite of his precautions, someone had been in the room while he was gone, checking on the progress of his research. It was like the prickly sensation one gets at the back of the neck that says you are being watched even though you can't ever catch anybody watching, as intangible and as inarguable.

Before he could take any additional precautions, or even think of any additional precautions he could take, he was summoned by Marilyn Van Cleve. Sam Aikens had died, and Pearce was wondering who Van Cleve could use as a conduit. It happened at his free clinic attached to the Center's walls. It had an external entrance so that the security of

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the hospital compound would not be breached or its purity compromised. He was examining a wiry old man in dirty working clothes that once had been dark blue. The old man was coughing from emphysema and Pearce smiled sadly at the package of cigarettes protruding from the old man's shirt pocket even though he could not smoke while within the Center's walls. Pearce heard unusual sounds from within the old man's sunken chest. He frowned and moved his stethoscope to another spot to listen more intently. On the third try he realized the sounds were words: the old man had learned the trick of esophageal speech, when cancerous vocal cords had to be removed. Perhaps, he thought, the diagnosis was not emphysema but cancer. The old man even had learned how to whisper into his chest cavity.

It was then Pearce realized what the words were saying: "Marilyn needs you. I'll be waiting across from the main gate at sunset. Come by foot." And then, as soon as the examination was completed and the free sample of bronchial inhaler was handed over, the old man rose from the examination table and left the room.

Pearce got through the rest of the day mechanically, unable to concentrate on the task at hand because of the possibilities that lay in front of him, half dread and apprehension, half anticipation. Finally, as the sun edged gold around a dark cloud on the horizon, he put his black bag and a second small bag into the front seat of his car and drove through the main gate, nodding to the guards as he passed through.

He pulled the car out of sight behind the ruins opposite the gate and looked around for the old man who whispered from his chest. The ruins of what seemed to be ancient restaurants and taverns for bored medical students were deserted. Pearce waited impatiently, not wanting to leave the safety of the car, not sure this wasn't a trap or a diversion.

After ten or fifteen anxious minutes, something tapped on his window. Pearce turned, startled, but it was the old man. When Pearce rolled the window down, the old man forced words into speech like hoarse whispers, "I said 'no car.'"

"How do you think I was going to leave the compound? On foot?" Pearce said. "Wouldn't that attract suspicion?"

The old man shrugged, coughing. Pearce got out of the car with his bags, feeling a shiver of—what? Anticipation? Apprehension? He didn't know which. Maybe both.

Behind the remains of what was once a concrete-block trash enclosure stood an antique motorcycle. Pearce hadn't seen anything like it for a quarter of a century. It seemed as big as a small horse, but it was old—dented and rusty and only the letters "Ha" and, widely separated, "son" appeared on the forward section. Pearce noted with a shiver of horror that the machine operated, if indeed it still worked, on gasoline with all its fumes and carcinogens.

The old man coughed and threw his leg over the saddle. He motioned Pearce to put his bags in the containers fastened on each side of the rear wheel and to take the jump-seat behind him.

"If you think I'm going to join you on this—this apparatus," Pearce said, "you're out of your mind."

The old man motioned again, impatiently, and nodded at the top floors of the Center compound visible over the tops of the ruins. Pearce looked longingly at where his car was hidden, but he remembered the computerized map and telltales, and shrugged, stowed away his bags, and got behind the old man.

The old man kicked the machine into life. He was stronger than he had seemed in the clinic. Pearce thought of him as the old man, but he probably was two or three decades younger than Pearce himself. As the engine roared like a wounded animal, unmuted by a muffler, Pearce wondered what he was doing here in the gathering dark, commit-

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ting himself to strangers on a quixotic mission that might end in disaster for everybody.

Then the motorcycle lurched into motion, its roar modulating into a husky snarl, and Pearce had no more time for reflections on his folly. Instead he hung onto the old man's emaciated waist as wind and dust tugged at his clothes and hair and beat into his face. The night was chilly, and the cold ate through his clothing and down to the bone. Now that they were traveling, the old man wasn't coughing as much, as if the strength of the machine he rode seeped up into his body through some kind of sympathetic magic.

The old man avoided all but short stretches of the trafficways and their patrols. Instead the motorcycle weaved through unlighted side streets, avoiding potholes and wreckage as if by instinct, skidding around corners, going over sidewalks and through yards to avoid barricades behind which lurked dangers that Pearce did not want to consider.

The experience was far different from traveling the same distance by car. After his terror subsided to a constant fear punctuated by panic, Pearce began to feel the inner city as a place where people lived rather than a jungle to be flown over or passed through. Like a medieval leech drawing blood from a patient dying of anemia, the suburbs had drained wealth from the inner city, and what the suburbs had started the Medical Centers had completed, taking block after block of housing for their expansion, pricing their snake oils and nostrums beyond the reach of the people in whose midst they lived and thrived. And yet the citizens endured. In spite of everything, they endured.

That was the strength of the people, he thought. They endured and they survived, and after all those who elevated themselves above their fellows had decayed from their excesses and destroyed themselves, the people remained. Pearce saw them now, looking out their windows into the uncertain night, standing on their porches to stare at the unaccustomed noise, in hovels falling apart around them, and realized their strength.

Their lives were short and disease-ridden—no better than the animals of the fields or the forests—which is why the Medical Centers remained in their midst, harvesting their antibodies and their antigens, their gamma globulins and their vaccines, even their organs. But they survived. They nourished each other between casual killings, they dreamed, they loved, they raised families, they got old too soon, and they died, often among friends, as opposed to the sterile dyings in the Medical Centers, no matter how long postponed, ignored by everyone except those paid to administer the medical last rites.

By then they had nearly reached their destination as they crossed the divided thoroughfare of the Paseo and slowed on what Pearce glimpsed on a sagging street sign as "Indepe . . . ven. . . ." The motorcycle veered off the poorly illuminated, four-lane street into a darker drive behind a dark building that hulked against the late evening sky like an abandoned warehouse. The old man who had ferried him here like some latter-day Charon cut off the engine and waited a moment in the sudden silence, testing the night for danger. Then, as if deciding for the moment that movement was safe, he removed the bags from the containers, handed them to Pearce, and motioned Pearce to follow.

As they entered a dark door Pearce noticed a sign above it, still intact. It was like an omen: "Children's Mercy Hospital," it read.

The building had been taken over by the homeless. The old hospital, once the new one had been built, had been used for a few years as offices for social welfare, then as an orphanage, and finally boarded up and forgotten. The poor had not forgotten. They had pried open

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doors and windows and made the building a warren for their fertility. Children played in the halls, barely lit by an occasional oil lantern, or stuck their heads out of doors to inspect the strangers passing by. Some came to tug at Pearce's clothing or the bags in his hands until the old man shooed them aside. Sometimes an adult made an appearance, an unshaved face to glare at them or a curious woman with a toddler tugging at her leg.

Children's mercy, Pearce thought. He hoped they got it, but he knew that this was a world that had little mercy except for those it favored, and they lived outside the inner city and had few children.

On the second floor was a room that Pearce recognized. He had never been there, but the layout was unmistakable. It was an operating room, no matter what uses had intervened. Glareless lights once had turned this room into day. Dials and gauges had lined the walls. Bottles of oxygen and anesthetic had been nearby. Tables and autoclaves for instruments. A T-bar for infusions. And a stainless steel operating table in the center.

Now it was lit by candles. It held only battered, old furniture pushed against the walls and in the middle a narrow bed. On the bed, propped up with ragged pillows, was Marilyn Van Cleve. She had her eyes closed but turned as Pearce entered with the old man and gave them a half-smile that turned into a grimace as a contraction seized her body. "You came," she whispered.

"I said I would," he answered.

"Not everybody keeps promises."

"I've always kept mine. When did the contractions start? How far apart are they?"

"Almost twenty-four hours ago," she said, panting. "They were ten minutes apart twelve hours ago, about a hour ago they were five minutes apart, and now they're down to two. I—just—can't—squeeze—him—out. I think it's time to help him get born."

Pearce nodded. "Get some boiling water," he told the old man who waited by the door.

"Too long," she said.

"At least," he said, "get me some soap and water to wash my hands."

While he waited for the old man, he folded back Van Cleve's long dress to just beneath her breasts and placed his hands on her belly to feel the contractions. "It's been a long time," he said. "I hope it hasn't been too long. And these operating conditions—they're beyond contamination."

"You can't hurt a Cartwright," she said.

"You'd better be right."

When the old man returned with a bucket of dirty water and a thin bar of soap, streaked with dark veins, Pearce shrugged and washed as thoroughly as he could. "I need more light," he said, and the old man brought two kerosene lamps that he placed on either side of the bed at Van Cleve's hips.

From the second bag Pearce removed a large plastic bag and from his black bag a bottle of alcohol with which he swabbed his hands and Van Cleve's belly before wiping it a second time with iodine. He pulled on a pair of clear plastic gloves that shrank to fit his hands and picked up an instrument that looked like a fat stainless-steel pen.

"I could give you a shot for the pain," he said, "but I'm not an anesthesiologist, and I don't know the effect on the baby."

"Go ahead," she said. "Knowing that injuries aren't fatal helps control the pain." And she did not make a sound as the laser made a vertical cut through her belly and into the womb.

He worked quickly, as if he knew what he was doing, and when the cutting was done reached his hands into her body and lifted out the baby, trailing its umbilical cord. The baby began to cry, loudly.

He looked up at Van Cleve. She was still conscious, though clearly in pain.

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"You have a son," he said. "I'm no expert, but he looks as big and healthy as any baby I've seen. I'd say ten or eleven pounds. No wonder you had trouble."

She laughed. "Give him to me." She held out her arms.

"Just a moment." He tied off the cord close to the baby's navel and again a few centimeters away before he cut it. "I need a blanket or a sheet or something," he said.

"Never mind that," she said.

He placed the screaming baby in her arms. Its body left reddish smears on her gown, but she didn't notice. Instead she looked down at the small face, which immediately quieted and began looking up at her and then around the room.

Pearce breathed deeply. Obstetricians were at the right end, the satisfying end, of the life process. Maybe he had made a mistake going into geriatrics.

He removed the placenta from the womb, along with the trailing umbilical cord to which it was attached at one end, and dropped them into the plastic bag. He adjusted the switch on his laser scalpel and sealed the cuts in Van Cleve's uterus and belly. They closed neatly, and he hoped there was no infection. But Cartwrights had to be resistant to almost every microorganism, and he thought, as he worked, that he could detect signs of healing even before the laser touched the wounds. He bandaged the incision and pulled down her gown as far as it would go.

Finished, he pressed the cuff of the gloves on each hand, and they peeled away. Once more he washed his hands in the bucket before returning his instruments and bottles to his black bag. Into the other bag he put the bag holding the umbilical cord and placenta. *Stem cells*, he said to himself. When he was finished he looked up at Van Cleve once more. She had placed the baby to her breast; it was trying to suckle.

"Thank you, doctor," she said. "Mother was right."

"I wish I could do something more," he said. "It isn't going to be easy for you, with recent surgery and a new baby. But from now on I bring only danger of discovery."

"Don't worry about me. I'll be able to move on in a day, and for now I'm among good people." She looked over at the doorway, where men and women had crowded to see what was going on. "When you don't have anything, you can let yourself care about others, because no one can use your kindness against you."

As Pearce watched, three men pushed their way through the throng into the room. One had a small, ragged blanket that he placed over the baby, the second, a shabby baby carrier that he put at Van Cleve's side, and the third, a shriveled orange that he gave to Van Cleve's free hand.

Pearce had the old man stop a block from his car. All the way he could feel the old man's body racked with coughs, worse now in the night air and without the adrenaline of the original wild trip. But the old man had brushed aside any suggestions for treatment and offers of help and Pearce trudged wearily toward the car as the old man roared away.

He had triggered the front door of the car when he was ten paces away, but as he was stooping to get in he felt his arms grabbed from behind.

"Easy," a man's voice said.

A light was splashed in Pearce's eyes.

He struggled, futilely. The arms holding him were strong. "I'm Dr. Pearce. This is my car."

"That's what they all say."

"Russell," Julia Hudson said. "We were worried when we found your car abandoned."

"Julia," Pearce said. "Tell this thug I'm who I say I am."

"Let him go," Hudson said. The hand released him and the light turned toward her. She was standing at the front of the car looking young and concerned. "The guard noticed your car identifier

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not moving, thought you might be in trouble, and notified me. What happened? We thought you were kidnapped, or worse."

Pearce had had lots of time on the ride back to think of an explanation if his car had been found. "I had a house call nearby, and when my car malfunctioned I decided to walk."

"A house call?" Hudson said incredulously.

"Difficult as that may sound," Pearce said, "I do make house calls. Ask Tom Barnett."

"Oh, I believe you," Hudson said. "It's just that I can't understand it, and I can't let you continue. It's too dangerous."

Pearce shrugged. "Can we go now?" He put his bags in the back seat of the car. "I've got some laboratory work yet to do."

Hudson got into the other front seat. "Take my car back," she said to the guards. She turned to Pearce. "I'd like to see how you're doing."

"It's pretty late," he said.

"I'm used to working late," she said, and he could think of no other excuses.

As they made their way through the night-stilled corridors toward the laboratory, he thought that surely she must be able to smell the blood on him or the odor of harsh soap or disinfectant, but she gave no sign. "I've been thinking about your suggestion," he said, "about the stem cells. An improvement in them must be involved in the Cartwright mutation."

She nodded. "They would produce more red blood cells, more platelets, more white cells for the Cartwrights themselves, and when transfused, for the ailing or aging recipient."

"Of course," he said. "I don't know why I never thought of that."

"Sometimes the original workers are too close to the problem to consider alternatives," she said. "And you might think about the primordial chordamesoderm."

"PC?"

"It causes formation of all the organs in the body before it turns off after the embryo has developed. But what if it were capable of being turned on again, by some feedback mechanism, to repair a damaged organ or stimulate the development of a new one—a new liver, a new kidney, a new heart, even new arteries—from surrounding tissue?"

They had reached the laboratory, and he put his hand casually on the palm plate as he punched in the code. He didn't want Hudson to know that he was taking extra precautions.

He raised the lid on his cell experiment and showed her his samples. "What I'm checking for is whether some portion of the DNA sample I'm working with might delay or eliminate apoptosis."

"Apoptosis?" she said. "It's been a long time since medical school."

"Not as long as it has been for me," he said. They both laughed and their eyes met. Pearce had the peculiar sensation that he was attracted to a woman who was young enough to be his granddaughter, perhaps even his great-granddaughter. And not only that, she might be one of those set to watch him. He went on hastily. "But I have the advantage of studying up for my research.

"Apoptosis is the unexplained phenomenon by which cells die. Given sufficient substrate and their byproducts washed away, cells will survive approximately forty-five cycles, so it may not be a matter simply of inadequate circulation leading to insufficient food or a build-up of waste or free radicals. It may be a built-in termination, a death-sentence that must be canceled."

"And has anything happened here?" she asked, looking back at the experiment in the machine before them.

He closed the lid. "Too soon to tell," he said. "In any case, it's probably just a practice run for the rare possibility that I might come into some authentic Cartwright blood."

She put a hand on his arm. "Take care

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of yourself, Russell," she said.

"Russ," he said. "You, too."

After she had gone, he went back to the experiment. He thought he could tell that all but two of the cultures had already started to die. Two. One of them might be an illusion, but two might mean that more than one segment of Van Cleve's DNA was involved.

He returned to his apartment with his second bag and hung the placenta by clamps from a shelf of the refrigerator. He cut the umbilical cord just above the place he had tied it off so that both drained into a stainless-steel pan. For the first time in years, he went to bed happy.

He awoke to panic. Alarm bells rang and somewhere a siren screamed. Pearce rolled over and checked the time—5:38—and fumbled into his pants and shirt and white hospital jacket. He stuck his feet sockless into shoes and moved toward the door before he remembered the priceless treasure in his refrigerator and the experiment progressing in his laboratory, and it all seemed too much of a coincidence.

He slowed his pace and opened the door normally. Residents were running up and down the corridor in various states of undress, shouting questions and getting no answers. Tom Barnett was waiting outside the door.

"Quick, Russ," he said, "let's get out of here!"

Pearce turned to double-lock the door before he turned back to Barnett. "What are you doing here, Tom?"

"Concern for you, Russ."

"You live on the other side of the compound."

"I was up early and heard the alarm. I thought you might sleep through it."

"Old men sleep lightly, Tom," Pearce said. "Let's go."

"What about the laboratory?" Barnett asked.

Pearce shrugged. "It will have to take care of itself."

As they turned toward the distant exit, Julia Hudson was coming toward them, relief on her face. "Dr. Barnett, isn't it? Russ, I was worried." She was fully dressed but without make-up. Even so, Pearce thought she was a remarkably attractive woman.

"Up early, too?" he asked.

"Paperwork," she said wryly, and then, "I'm not much of a sleeper."

As they moved toward the exit to the outside, following the other residents, who now had decided that their lives were more important then their belongings, Pearce asked Hudson, "What's the alarm?"

"Fire," she said. "Two. One in the basement. One in a janitor's closet on the top floor. Like the compound, the hospital is being evacuated as a precaution."

"Two fires? That sounds like arson."

They emerged into the open air of the parking lot. It was filled not only with residents but with nurses and interns tending patients in wheelchairs and gurneys

"That's what I think."

"One in the basement?"

"Near your laboratory. But don't worry. It's under control."

"Why would someone want to burn a hospital?" Barnett asked.

"Why, indeed?" Pearce said.

"A disgruntled employee?" Hudson suggested.

"An unhappy patient?" Barnett added.

"Or one who's mentally disturbed?"

"Or someone denied care?" Pearce said ironically. "Two at the same time?"

The distance between the fires rendered improbable the thesis that one person might have set both, and the possibility of two unrelated people acting simultaneously was even more unlikely. They all saw that.

"Not only arson," Pearce said, "but conspiracy. But why? Maybe as a warning that the hospital is vulnerable. Maybe as a ploy to empty the buildings so that rooms can be searched, perhaps valuables stolen."

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"We'd better get back inside," Hudson said.

Pearce glanced around the disheveled parking lot and its disheveled inhabitants. "I think you're right."

But before he could get back to his apartment door, he was stopped by a large male nurse. Pearce couldn't remember seeing him around the hospital, but something about him seemed vaguely familiar. "Dr. Pearce, there's an emergency in your wing."

Pearce waited for Barnett to volunteer to take care of it, but Barnett said nothing. "I'll follow you," Pearce said, and had time only to notice, as he passed his apartment on the way to the elevator, that the door seemed untouched.

The nurse preceded him, glancing back occasionally to see if Pearce was following. He wore green scrubs that left his biceps bulging incongruously below the short sleeves. When they arrived at one of the private rooms, the nurse stepped aside and stood with his back to the door as Pearce entered.

A man in a wheelchair sat on the far side of the room, looking out at the smoggy inner city. He turned as Pearce entered. He looked bulky and malformed under his robe. Pearce looked at his face. The man was old, perhaps close to the century mark, and his face, which once might have been round and full, was little more than skin stretched over the prominent bones of his face. But now that the subcutaneous fat had been skimmed away by time, the strength of the man was revealed in the set of the jaw and the fierceness of the eyes. Among the wrinkles around his eyes were the faint reminders of old scars; a long one ran down his right cheek to the point of the jaw. His nose had been broken once or twice.

"You don't remember me, Dr. Pearce?" the man said.

Something stirred in Pearce's mind, a vision of a sign on a glass door panel, a man in a cocoa-colored tropical suit, and later the same face bearded and battered. "Locke," Pearce said. "Jason Locke, the private investigator I hired to find Marshall Cartwright."

"The private eye you hired to make sure that Marshall Cartwright could not be found," Locke said.

"And after all these years have you come to report success?" Pearce asked. "Have you found him?" The combination of Locke's age and determination made Pearce shiver inside, but he wasn't going to let Locke know.

"No," Locke said, "and I've been looking ever since. I'm the Executive Director of the National Research Institute."

"Ah," Pearce said, as pieces fell into place.

"The organization that has been funding your research for the past fifty years, but, as you have deduced, its principal mission is to find Marshall Cartwright and his children. I didn't know the story until after Leroy Weaver's death, when his doctor, a man named Easter, and his private secretary, a man named Jansen, offered me the chance to work for them. It was my idea to recruit other people of wealth and declining years, and to organize the Institute along its present lines. Easter and Jansen are long gone, but the search continues."

"You switched sides easily," Pearce said.

"I was never on anybody's side. You hired me for your purposes, and I allowed myself to be hired by Jansen and Easter for mine. Besides, we're all in the Ponce de Leon business."

"And has your search been successful?"

"No more than yours. We came close once," Locke said, almost wistfully. "Had her in our hands. But she was spirited away, perhaps by Cartwright himself."

"But you keep on."

"Just as you do. People die easily but hope dies hard. And old people hope until the end. Death has come to billions of people in the fifty years the Institute has been functioning, and to dozens of

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the Institute's board of directors, but their estates revert to the Institute and the search goes on. Actually, as time passes the possibilities for success increase."

"How so?" Pearce asked. "I'd think the trail would have gone cold long since."

Locke laid his right hand out palm up, as if to reveal a gem of truth. "The more Cartwrights there are, the more difficulties they have keeping hidden and the more chances we have to identify one. Sooner or later they will begin to pop up like corks in the ocean."

Pearce remembered a woman and a baby in an abandoned operating room. "What brings you here?"

"You," Locke said.

The bluntness took Pearce aback. "Me?"

"Your reputation as a geriatrician is international," Locke said. "Even without the urban myth of Leroy Weaver's rejuvenation, you would be renowned as one of the magicians of senescence. I thought it was time for a check-up."

"What seems to be the problem?"

"Old age," Locke said. "I may look good for my years, outside of the nerve damage that keeps me in this wheel chair. I've had growth hormones and fish oil, vitamins and health foods. My arteries have been roto-rooted and I've had a heart and lung transplant and two new kidneys. But I feel old."

"Apoptosis," Pearce said.

"What's that?"

"The cells themselves age and die after about forty-five divisions. Almost as if they have a counting mechanism."

"Except for the Cartwrights."

"And cancer cells. You want to be young again, like Leroy Weaver," Pearce said. "But that happened only once. You are old. I'm old. It's not a bad thing to be."

Locke's expression wore a steely rejection. "That was all right when there was no alternative. But now there's a chance for immortality, and only a helpless fool would settle for anything less."

"I guess that's what I am, then," Pearce said.

"No, you're the most powerful man around," Locke said, "and that's why we decided to renew your grant."

"We?"

Locke smiled. "Me, then. I decided to renew your grant."

"And why did you turn down the renewal in the first place?"

Locke studied Pearce as if gauging how open to be. "I wanted to see how you'd react."

"You wanted me to make a personal appeal?"

"Maybe."

"Be spurred to greater effort?"

"If that were possible. Time passes swiftly. Some of us are getting nervous."

"And why did you set the fires this morning?"

Silence grew deep in the room before Locke said, "You know about that?"

"I don't believe in coincidences. It was a mistake to set two."

Locke spread his hands helplessly. "Subordinates make mistakes. They don't make them twice."

"But what were you after?"

"Proof. Evidence. Anything." Locke bent his head forward to prop his chin on his fingers.

"Proof of what?"

"Of your Cartwright connections. Of your success with the *elixir vitae*."

"What makes you think that I could make connections where you could not?"

"They might contact you; they wouldn't trust me."

"There's no reason for them to contact me. In fact, there is every reason they shouldn't, just as they shouldn't contact each other. All they need is freedom and the opportunity to be fruitful and multiply and make the species immortal; sentimentality is their enemy."

"I'm not interested in the immortality of the species, nor are any of my board of directors. The world ends when we do."

Pearce went on as if he could elimi-

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nate Locke and his board of directors by ignoring them. "And they don't know anything about you. I didn't."

"There's a mythology that encompasses us both."

"As for the *elixir vitae*," Pearce said, "it is more complicated than I thought, not only the gamma globulins but the stem cells and maybe primordial chordamesoderm. But why would you think I had been successful?"

"There's your appearance, for one thing," Locke said. "You're not much younger than I am, but you could pass for fifty, say—no more than sixty anyway."

Pearce looked at Locke. "You're the second person who has told me that. I'm beginning to believe it myself. But it's all due to choosing long-lived parents, clean living, and a positive attitude."

Locke shrugged. "There's intuition as well: when you've been in the 'needle in a haystack' business as long as I have, you get a sense for these things."

"You also get paranoid," Pearce said.

Now it was Locke's turn to look at Pearce.

Pearce turned toward the door and saw the outline of the big male nurse against the corridor wall. In that moment it transformed itself into the image of a large shadowy figure looming over him out of the darkness, holding a club. He remembered a laser that lit up the night, and he understood. The nurse was not a nurse but a bodyguard, and he performed other services as well, perhaps even setting fires.

Pearce turned back to Locke. "No doubt you hoped I would hurry to my laboratory to rescue my samples," he said, "but I'm afraid there's nothing there to rescue. Or to search my apartment for notes. But I don't keep them there, as Tom Barnett no doubt told you."

"Who?" Locke asked.

"But I'll accept you as a patient, if you're still serious about that, because I'm a physician and that's what I do. And I will accept your grant to perform my research, if you're still serious about that, because I need it and the work is important."

Locke stood up, revealing what had been malformed about his figure. Through the part in the gown Pearce could see a metal framework that supported Locke's body from his shoulders to his ankles and no doubt turned Locke's nerve impulses into movement. Locke moved toward Pearce. Pearce kept himself from recoiling as Locke grasped his wrist in fingers like steel. No nerve damage here, or perhaps the external skeleton dived into Locke's hands to become bone and sinew. Herod had turned himself into Frankenstein's monster.

"I will fund your research," Locke said, "because I think you may be the only one who can do it. I believe you have Cartwright connections because that's what I would do if I were in your place. And when you have the elixir, you will turn it over to me."

"I will publish the results like any scientist."

"You will submit them," Locke said. "They will not be published."

"You're over-confident."

"Just realistic. I know my powers. And I know what would happen to the world if the elixir became public knowledge. There would be murders, riots, wars—and later on there would be the insoluble problems of overpopulation or a dropping birthrate and stagnation. But you will do the research because you are the kind of person you are, and you will give it to me because I am the kind of person I am."

Pearce pried Locke's hand from his wrist, one finger at a time. "I'm not your creature," he said. "But we understand each other. I will synthesize the elixir with the hope of getting it free from you somehow and getting it to the people who can use it more wisely than you or I. And if I fail at that and it becomes

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yours to do with as you wish, I won't despair. It will take the pressure off the Cartwrights, and gradually, no matter what you do, the secret will leak out and it will become the property of all humanity."

Pearce turned and walked through the door past the threatening bodyguard and through the familiar corridors and down the elevators until he found himself once more in the clean, cool purity of his laboratory, his refuge from the aggravations and petty concerns of the outside world. Now he knew that his apprehensions about someone's presence while he was gone had been mere paranoia. If Locke had known he had samples of Cartwright blood, he would never have let him go without confiscating them.

Someone buzzed at the door for admission, and Pearce went to the intercom. "It's me, Julia," a voice said. "Are you all right?"

Pearce went into the airlock to admit her, hoping she was alone but knowing that it didn't matter: he could not exclude the world. She was alone, and she took hold of his arm in reassurance as she entered. "Sure," he said.

"So much has happened."

"My grant has been renewed," Pearce said. "It seems the Executive Director of the National Research Institute has checked in as a patient." Did he detect a flicker of awareness? "But I think it's time Tom Barnett moved on. He's capable enough to handle his own operation. Do you think you can find him another position?"

They had moved into the laboratory and stood in front of his experiment in apoptosis. "I'll do better than that," Hudson said. "I'll recommend him to a friend in Chicago, who's looking for a senior geriatrician."

"I'll need a new assistant," Pearce said. "Would you like to apply?"

She looked at him as if he had made a declaration of love. "I'd have to give up what little free time I have, like reading and maybe some social obligations, but I can't think of anything I'd rather do."

"I was hoping you'd give up administration," he said.

"Not yet," she said. "Maybe in a couple of years."

"I want you to see this," he said, opening the lid of his experiment. All the cell cultures were dead except for two.

"Success already?" she said.

"It's a beginning," he said, and put his arm around her shoulder. But it was more than a beginning. It was the beginning of the end. The long search was almost over, and he knew he would discover what the alchemists had searched for all their lives: the secret of immortality. But he would not give it to the world until Locke was dead; no doubt he would be replaced by someone just as determined and just as ruthless, but he would not have Locke's combination of qualities nor experience.

Julia put her arm around his waist, and they stood looking down at the immortal cells. He felt like the hero of an interplanetary romance.

And yet he knew that it would take a long time before he was confident that Julia herself was not one of Locke's agents, as Barnett had turned out to be. He could love her, and he would have to trust her, but he might never be sure.

Maybe that was the human condition. ■

(EDITOR'S NOTE: This story is part of the same history as "New Blood," which first appeared in Astounding, *October 1955, and was the basis for [among other things] the television movie and series* The Immortal. *A new, expanded edition of* The Immortals *will be published by Pocket Books in July.)*

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SCIENCE FACT

THE FUTURE OF TRANSPLANTATION

K.J. Zimring

Transplantation

I have only one recurring nightmare. I'm a medicine resident, just finishing up years of school and studying, so you'd think it would be the one about having a test I haven't studied for. It's not, though. It's this: I'm sitting up in a hospital bed, I've just had a heart attack, and they're getting me ready for a transplant. I wake up in a cold sweat, but the truth is that I'd be lucky to be in that position. The waiting list for organs is incredibly long, and it's a simple fact that most of the would-be recipients will die in line.

So what's the solution? Three options are under investigation: producing new human organs, creating better artificial organs, and using organs from animals. We'll take a look at all three of these possibilities, the advantages and the obstacles inherent in each one, and consider the question facing transplantation today. Where's your next organ coming from: will it be man, meat, or metal?

* * *

Transplantation's Past

It's hard to believe, but the first successful human transplant is nearly a century in the past. In 1905 a workman blinded by lime consulted an ophthalmologist named Edward Zirm. Zirm replaced the man's corneas, restoring his sight, and the transplant lasted without complication for the rest of the man's life. It was an exciting beginning, and it was followed by a half-century of dismal failure.

The next major success came in 1954. A twenty-three year old man named Richard Herrick was dying of kidney disease, and was lucky enough to have a devoted identical twin. His brother Ronald agreed to the Brigham's suggestion of an experimental surgery, and donated a kidney. Both did well post-operatively, especially Richard who snagged not only a new organ but also a wife, as he married one of the recovery room nurses.

For a while, though, solid organ transplantation seemed limited to those with the foresight to provide themselves with an identical twin. Transplants between

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unrelated donors failed, and it became increasingly clear that the immune system would not tolerate the intrusion of foreign tissue. The cornea was found to be the exception, not the rule, a privileged site exempt from attack. Progress stalled until 1962, when a chemist named Gertrude Elion invented Imuran, a drug with powerful immunosuppressive abilities. Together with the steroid prednisone, an anti-inflammatory agent, organ transplantation became a possibility for everyone.

Even with Imuran, life post-transplant was difficult and often short. The first successful heart and liver transplants were performed, but the drug was toxic and its side effects were difficult to endure. The next real breakthrough came in 1983 when cyclosporine, a drug derived from a Norwegian fungus, hit the market. Where Imuran was a frontal assault, a wholesale destruction of the entire immune system, cyclosporine was a back-door assassin, allowing a targeted suppression of the T cells. In a short time, transplantation changed from an experimental oddity to a realistic option for end-organ failure. Cyclosporine sales today exceed one billion per year, evidence of its continued necessity post-transplant.

State of the Art

In 2001, surgeons performed 24,076 transplant operations. Heart, lungs, kidneys, liver, pancreas, even intestines: all flying across the country, often by private jet, in the ultimate out-of-body experience. Organs don't have time to wait for a connection; the longer the organ is in transit, the lower the chances of transplant success. Hearts are the most sensitive, doing progressively worse after six hours without an owner. Livers can't last more than twenty-four hours, while the kidneys are the hardiest, able to make it on their own for a day and a half. Recipients who can be reached in time are selected by their need (sickest first) and by their immunological match for the organ.

Despite this success, it's increasingly obvious that supply can never meet demand. 24,792 transplants were performed in the United States in 2002, a testament to the abiding care and generosity of the 12,741 donors. Unfortunately that leaves 80,692 people, at this writing, still waiting on the list.[1]

The Artificial Option

So what do you do if you're failing fast and it looks like a transplant just isn't going to come your way? At least for hearts, an emerging alternative to a "gently used" human organ is the mechanical variety.

The first artificial heart, the Jarvik 7, was implanted in a Seattle dentist named Barney Clark in 1982.[2] It sustained his life for 112 days, although he never recovered to the point of being able to leave the hospital. Since then, Jarviks have been used by over seventy patients while awaiting a human transplant, including one patient who set a record of 18 months on the device. Its design, however, is not compatible with a normal life. Its pumping action is driven by compressed air, which enters the chest through penetrating hoses. In addition to the aesthetic problem, the tubes also provide entryways for bacteria, making infection a significant concern.

The next generation of artificial heart arrived in July 2001.[3] Surgeons in Louisville implanted the self-contained AbioCor heart in a patient named Robert Tools. During the seven-hour surgery his ventricles were removed, and the two-pound titanium organ inserted in their place. His atria were left intact and sewn down to the top of the AbioCor. Unlike the human heart, the AbioCor is three-chambered, with only one ventricle instead of the normal two. The base of the artificial heart was therefore connected up to both the pulmonary artery and the aorta, with blood delivery alternating between the lungs and the rest of the body.

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No external hoses are necessary to drive the AbioCor; power is transmitted by a wireless energy-transfer system. An external battery worn on Tools' belt sent energy magnetically to an internal coil placed beneath his skin. The internal battery stores thirty to forty minutes worth of power, which gave him time to change clothes or shower. The external battery is rechargeable, lasting about four hours, permitting time away from the wall socket.

The results of this surgery were a significant improvement over the Jarvik. Tools survived for 151 days, an impressive result given that he needed to have a life expectancy of less than thirty days to even qualify for the experimental treatment. The second AbioCor transplant had even better results. The patient, Tom Christerson, received his artificial heart in September 2001, and lived with it for nearly a year and a half. Even more significantly, he was able to leave the hospital, returning to live a normal life in his own home.

So what's the problem? With results this good, won't human heart transplants become a thing of the past? The answer is that there are two enormous roadblocks to a comfortable life with an artificial heart.[4] The first is infection, which occurs less frequently in the new self-contained models, but is still a real threat.

Bacteremia, waves of bacteria flowing through the blood vessels, occurs every day for most people (up to 15 minutes of bacteremia every time you brush your teeth!). The most tenacious of these bacteria can seize on an artificial organ, and begin to grow. Artificial heart valves have had this problem for years, but an entire metal heart would provide veritable acres of growing space for these bugs. This is the flip side to the inability of an artificial heart to interact with the immune system. On the one hand, patients don't need immunosuppressive drugs to prevent rejection, but on the other, the artificial organ can't help the immune system clear an infection the way that living tissue can.

An even tougher problem, however, is clotting. Blood catches and snags on the metal surface, and clots form quickly. When these clots hit the smaller capillaries, the results are devastating; clots in the lungs can suffocate, and clots in the brain cause strokes. Patients have to take medication to thin the blood, such as Coumadin, a drug originally derived from rat poison. Coumadin is necessary for other heart problems but the levels needed to prevent clotting for a whole metal heart are very high. This has an obvious downside: clots can't form anywhere else either. Bruising is a serious concern, and a bump on the head can be fatal. The AbioCor heart, fortunately, to date has shown fewer of these two types of complications than other artificial heart systems. Still, the quality of life post-transplant will likely be determined by the severity of these problems.

Furthermore, all of these successes apply only to heart transplants. As far as other artificial organs go, we're not even close. A heart is at base a simple pump, something we can easily make, but there's no machine that can replace the liver or the pancreas. For kidneys, there are dialysis machines which can perform the same function of filtering waste products from the blood. Unfortunately, the mechanical version is about six feet tall and three feet wide, inconveniently larger than the average person, making implantation difficult.

Pork: It's Not Just For Breakfast Anymore

Given these problems, some researchers have turned to xenotransplantation. Where transplants between non-twin humans are called allografts, a transplant from one species to another is called a xenograft. Xenografts have actually been used on a small scale for years already; pig heart valves are often used to replace defective human ones. Tissue valves possess one major advantage over artificial valves: anticoagula-

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tion is rarely necessary.[5] Strokes on the one hand, and over-thinning on the other, are much less significant concerns.

Considering this, why not go whole hog? Why not take the whole heart, instead of just picking out the valves? Many researchers have been working on doing just that, and have unfortunately encountered major obstacles.

The biggest problem at this point is the one which originally prevented human-to-human transplants. The immune system, although willing to take small valves, takes violent exception to the presence of the entire porcine heart. As far as it's concerned, there's just no good explanation for a huge chunk of pig flesh getting wedged into the chest.

The difficulty is that the system not only reacts, as it would to a matched human transplant, and it not only overreacts, as it would to an unmatched human transplant; the problem is that it completely and utterly loses it. Within minutes of interspecies transplant, antibodies attack the new organ and destroy it, a process which is called hyperacute rejection.[6] The organ turns black, and must be removed before the immune system spirals further out of control, elaborating enough toxic chemicals to kill the entire person.

So what about Baby Fae, the baby who received a baboon heart transplant in 1984? Wasn't that xenotransplantation, and she made it more than minutes, right? The answer is, as Snowball could have told you, that not all animals are created equal. We actually share 95% of the same genes as baboons, making them far less "xeno" to us than pigs are. The antibodies of hyperacute rejection attach to sugars on the outside of the organ; pigs and humans have different sugars, unlike humans and other primates. The lack of this xenoantibody problem made the baboon heart tolerable with immunosuppressants, but still the baboon transplant lasted only 20 days.

Non-human primates, however, are not really a good source for organs. It's not just that they are more intelligent, and more sympathetic, than pigs. The problem is that the risk of infection is far more serious with a closely related species. Viruses are generally species-specific, and there is less risk of transmission from a pig than from a primate. Considering that HIV crossed over to humans from another primate species, this is no trivial concern.

Therefore research has focused on overcoming this xenoantibody barrier, and the first steps have already been taken. The same company which cloned Dolly the sheep has now cloned pigs that lack one copy of a sugar called alpha-gal.[7] These will be crossed, in the hopes that offspring completely lacking in the sugar will result. Primates lack alpha-gal naturally, and it's known to be a major focus for hyperacute rejection. It's unlikely that this will be the only foreign sugar necessary to provoke organ destruction, but by the same method it may be possible to make a population of pigs with immunologically acceptable hearts.

As far as other organs go, some researchers have speculated that there may be more success with xenotransplanted livers than with hearts.[8] Livers are known to be more resistant to antibody-mediated destruction, and may therefore be better candidates than hearts. At any rate, we may find an answer to an interesting question: just what is the alcohol tolerance of a pig, anyway?

Fooling Yourself: How Do You Know What's You?

Sugars aren't the only problem in xenotransplantation, though. The hurdle of hyperacute rejection is just the first obstacle on the course. Once past that, there is delayed xenograft rejection, in which immune cells such as macrophages and natural killer cells begin to attack the organ.[9] High levels of immunosuppressants, far more than are currently used in human transplants, are needed to preserve the organ. After that, there's still more rejection, with the T

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cell mediated acute and chronic forms so well known already in human transplants.

Researchers such as David Sachs at the Mass General have been investigating new methods to circumvent this ongoing attack. To do this, it's necessary to understand exactly how the immune system decides what's you, and what's not. This is an interesting problem for a system that's essentially blind; it can't see the chest opening, and it can't see the old heart being cut out and replaced with a new one. So how does it know what happened?

The answer is that each cell in the body puts a protein called MHC I on its surface. MHC I looks a lot like a cup, on a molecular level, which makes sense because its purpose is to hold things. It's not too fussy about what it holds, and generally just scoops up whatever protein it can find inside its cell. Now off in another part of the body, in a strange little organ called the thymus, T cells are going to school. Huge numbers of T cells are made, each with a unique MHC/protein-recognizing receptor.

These T cells start in first grade, at the very outside of the thymus, and meet up with teacher cells covered with MHC molecules, all of them stuffed full of proteins. The T cells feel up the MHC molecules, and if they get a match—they're killed on the spot. The purpose is to weed out any T cell that recognizes the proteins made by the host. They progress on through the organ, seeing more and more MHC/protein complexes, and if they make it through to the middle without getting activated, they're released into the circulation. This is an imperfect system, as any look at the number of autoimmune diseases like multiple sclerosis will tell you.

Once out in the body, these T cells are free to scan along tissues and organs, destroying anything that matches their receptors. The real purpose behind this system is to rid the body of viruses and other sneaky attackers that hide intracellularly. A cell that's been infected by a virus will make primarily viral proteins, which will end up in the MHC on the surface, and be "seen" by the immune system. The less well-matched an organ, the bigger the differences in proteins on the MHC, and the more intense the immune response. (There's more to this process, of course. A similar system using a closely related molecule called MHC II, present on immune system cells, is even more powerfully able to trigger an immune response.)

Here's where Dr. Sachs' idea comes in. His group proposes transferring the thymus of the donor animal, along with the organ itself.[10] This isn't a practical approach in human-to-human transplants, partly because there's just one thymus and many recipients, and partly because the thymus tends to waste away with age. With a porcine donor, however, the thymus could be transplanted along with (or prior to) the heart itself. The pig thymus could "teach" the T cells of the recipient person not to attack the heart. If successful, it could lead to acceptance of the foreign organ, without the need for immunosuppressive medications.

An Interesting Idea: You Are What You Eat

Another ingenious method for avoiding rejection proposes taking advantage of oral tolerance.[11] If you think about it, the largest amount of non-you material in your system on any particular day isn't the viruses and bacteria that you're exposed to; it's the stuff you deliberately eat. So why doesn't the immune system have a conniption about all that foreign matter coursing through your GI tract every day? It's not that it doesn't end up in the circulation—studies have found significant amounts of chicken proteins in the blood after eating eggs, for example.

The difference appears to be in the type of cells which pick up the foreign proteins. Protein that's poked under the skin, like a vaccination, is picked up by

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powerful antigen presenting cells—cells able to make a T cell sit up and react. Protein that's presented by certain cells in the GI tract, on the other hand, don't usually get much of an immune system response.

In fact, it appears that the ability of the T cells to respond may even be inhibited after they've interacted with these weak cells. That has led some researchers to propose feeding a portion of the donor pig to the recipient, in an effort to promote organ acceptance. That doesn't seem so bad, except that unfortunately, to avoid decomposition of the proteins, the sausage would have to be raw . . .

PERVerts and the Government: More Problems for Xenotransplantation

Nevertheless, xenotransplanters face more difficulties than rejection alone. Although pigs pose less of an infection risk than primates, concern has arisen over a porcine endogenous retrovirus (PERV).[12] This is not an active retrovirus, like HIV, but one that millions of years ago inserted itself into the pig genome, and lost the ability to get itself back out. It's been so long since it was active, in fact, that it's classified as a "fossil virus." Still there was enough concern around the issue to prompt the US FDA to create guidelines and a xenotransplantation committee to oversee the area.

The resulting studies have shown little reason for concern. Retrospective studies of patients given pig tissues, such as valves, have shown no evidence of PERV or other new viral infection.[13] Despite US caution, other countries have proceeded with these xenotransplants, with a group in Mexico even claiming to have cured diabetes with an encapsulated pig islet cell transplant.[14]

While these results are still in doubt, it seems likely that pig xenotransplants will continue, and with less risk of vector transmission than with more closely related primates. After all, after some early liver primate xenotransplants, measurable levels of simian foamy and baboon endogenous retrovirus genomes were detected in transplant recipients.[13] Worrying about long-dead pig viruses after we've put baboon organs in people seems like a real case of shutting the barn door after the horses are gone.

Cloning: There's No Organ Like Your Own Organ

Still, all the problems seen with artificial organs and with animal organs boil down to one thing; there's no perfect substitute for your own flesh. The ideal solution would be to be re-create your own organ, with your own natural immunology. Unfortunately, that goal will be harder to achieve than all the other options discussed already.

In science fiction, not to mention the real life Raelian cult, the perfect source for that desperately needed organ is your own clone. This solution, while it will undoubtedly create the necessary organ, is somewhat impractical (not to mention more than a little illegal and immoral). First of all, how do you know that you're going to end up with a disease fixable by transplantation? You could put all that money into raising a clone, then get diagnosed with cancer and not have any resources left for your chemotherapy.

Secondly, some of the recent results with cloning have raised an interesting obstacle. One particular phenomenon has been observed in the cloned offspring from every variety of animal, from mice to sheep to cattle: they're morbidly obese.[15] Studies have investigated this observation, and have confirmed that the cloned animals do have significantly more adipose tissue (and are not merely "big-boned"). The cause is as yet unknown, although it may be related to *in vitro* growth conditions. Together with findings of pneumonia and early arthritis, it's entirely possible that your sumo-sized clone baby could need a great deal more medical care

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than you do.

Far more ultimately practical, although more technically difficult at the present time, would be the production of only the organ needed, at the time which it is needed. Stem cell research may hold the key to this advance, as discussed in the November 2002 *Analog* article on stem cells and human cloning.[16] Most of the cells in the body are mature; that is, they have determined their physiological career and cannot be changed from it. Heart cells, for instance, are so mature that they not only will not make any other type of cell, they will not even reproduce themselves.

Stem cells however, are pluripotent; that means that they are capable of becoming any type of cell in the body. The ultimate dream of transplantation, then, is to be able to take a stem cell from a person and grow it *in vitro*, in the lab, into whichever organ is needed. This requires two main areas of advancement. First of all, we need a far greater understanding of the mechanism by which a cell becomes part of the heart, rather than part of the liver or the lungs, as well as the ability to replicate that transformation outside the body.

Secondly, we need mechanisms of creating and sustaining the structure of that organ. We may learn to create the most perfect human heart cells, but it won't do much good if they end up as a puddle at the bottom of a dish, rather than a structurally functional pump. Furthermore, we'll also need to learn how to weave in other cell lines—a heart is going to need blood vessels and nerves in order to be a good replacement.

Some simple studies have been done already to investigate integrating structure and cell culture. Researchers at the University of Massachusetts in 1997 managed to grow cartilage cells onto a biodegradable plastic framework.[17] By the time the cartilage cells were mature, the framework dissolved, leaving nothing but the cartilage cells in the desired shape. A similar approach could be taken for the heart, with myocardial cells grown onto a timed-to-dissolve plastic shell. Other cell lines, once established, could be put in the right place.

The Bottom Line

Overall, obstacles are obvious for each of the three main avenues of research. Xenotransplanters must overcome the problems of rejection, from the sugar-related hyperacute rejection to the insidiously slow T cell run processes of acute and chronic rejection. Success in this area will depend upon the ability to produce cloned animals lacking in the proteins which cause human response. Even if these scientific hurdles are cleared, xeno faces difficulties with government approval. Despite lack of evidence for the possibility of a PERV-type virus causing human infection, fear of cross-species contamination may impede continued progress in this area.

The second branch of research, artificial organs, is showing the most impressive results right now. Transplants of the AbioCor artificial heart have done well, and have allowed significant improvement in the quality of life for their recipients. However, it may not be possible to adequately overcome the issues of infection and clotting. In the end, the price of an artificial heart may be living with frequent antibiotic treatment and high levels of anticoagulation medication. Furthermore, the only artificial organ close to common use is the heart; no artificial livers or lungs or kidneys appear to be in the near future.

In vitro growth of human organs remains attractive—a lab grown copy of your own organ wouldn't have the problems with infection, rejection, and clotting that the others do. Still, this research is really in its infancy. The ability to take a stem cell and end up with an organ is the least foreseeably attainable of transplantation's current goals.

The solution, in the end, may not lie entirely within one branch of study. Combinations of artificial and in vitro

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systems may fix the problems inherent in each. It may become possible to coat artificial hearts, for example, with human cells from the recipient. This natural coating would prevent the blood from clotting on the exposed metal surface, reducing the need for anticoagulation. These cells could also interact normally with the immune system, which would fix the problems of bacterial infection. Other proposed artificial/human systems offer potential solutions to the difficulty of creating a mechanical liver. Foreign liver, either xeno or unmatched human, could be wrapped inside an artificial coating. This outside layer could be designed to allow small nutrients to penetrate, but prevent the cells of the immune system from entering.

For now, though, for all those people waiting on the transplant lists, there's just one thing that we can really do. Sign that donor card! ■

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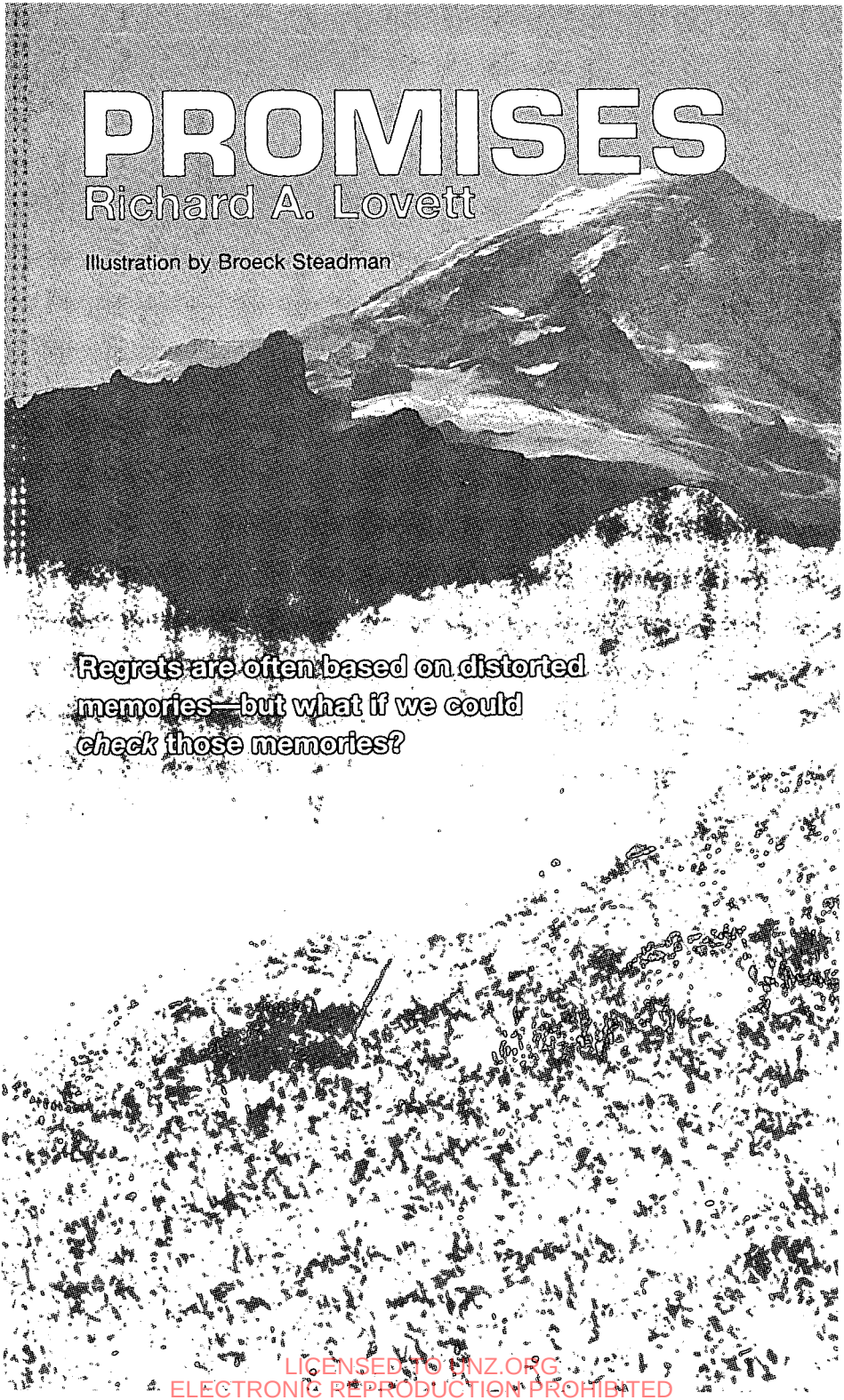
PROMISES

Richard A. Lovett

Illustration by Broeck Steadman



Regrets are often based on distorted memories—but what if we could *check* those memories?

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I'd nearly reached the crest of the hill when my trick knee decided to go out. For once there really was pain. Or at least a twinge. "That's it for today," I said, easing my fifty-pound pack to the ground. Years ago I learned never to drop a backpack, even if you're dead tired—not unless you're ready to replace the frame. The new composites are supposed to be indestructible, but it's a hard habit to break. "The knee's had it," I added, just to make sure Donnie got the point.

He may have been about to start college, but his response was pure teen-ager. "But Uncle Will! It can't be more than half a mile." He dropped his own pack with a thud that made me wince and flipped his comp visor down over his eyes. "And it's downhill all the way!" Donnie couldn't read a topographic map if his life depended on it, but the comp did it for him. Even when mountains or canyons blocked the satellite feed, the inertial tracker usually knew where we were better than I did.

I shook my head. "Downhill is the hardest thing there is on sore knees," I said, which would be true enough if my knee really were sore. My nephew still hadn't realized that it only acted up when I wanted it to. I hoped to keep it that way. "We'll camp here."

Donnie hesitated a moment, gazing at the stark volcanic landscape surrounding us. "Where?"

He was looking at me a bit too expectantly, and I suspected that behind the tinted plastic he'd activated his thought logger to record a multisense image of my reply. Years ago, when thought loggers first came out, my childhood friends and I had used them continuously, recording real-time diaries of everything that happened to us—even to the extent of recording our own reactions to replaying prior experiences. Having grown up with thought loggers, Donnie took them for granted and used his more sparingly, recording only experiences he expected to be worth reliving. I wondered how long it would take him to discover the vast distinction between remembering and wishing to forget. I myself hadn't touched a thought logger since—well, for a very long time.

Even if he'd been playing up the drama a bit for his log, Donnie hadn't asked a bad question. We were two-thirds of the way through a seventy-mile trek along the Pacific Crest Trail in the Oregon Cascades. This morning we'd dropped into a broad valley, then climbed steadily for 2,000 feet, until now we were traversing a cinder cone whose lower reaches must once have oozed pasty lava. To the left rose a steep slope of volcanic cinders; to the right the lava fell away in a jumble of jagged rock.

It certainly looked like a poor site for bedding down, but I'd already picked a spot, which I now pointed out to Donnie, a tiny embayment in the lava flow, where drifting cinders had formed a smooth surface. It was practically on the trail and barely big enough, but it was a hillside vantage point that promised a stunning sunset view. There was even a convenient snow bank from which we could, with effort, melt drinking water. Or if Donnie preferred, he could hike his half-mile and fill our bottles from a stream near the meadow where we were supposed to be camping. He wouldn't have to swat many mosquitoes down there to understand why I preferred it here—high, dry, and breezy—regardless of where our permit said we'd be camping.

I hate permits. They ruin the spontaneity that is one of the things I once cherished about backpacking—the ability to rearrange my plans however I wish with no one to answer to but myself. I'll admit permits are sometimes necessary in overused areas,

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but I tend to avoid those. The main reason I'd come here, to some of Oregon's most popular backcountry, was that I'd promised Donnie's mother I'd take him somewhere reasonably tame, where there was little chance of harm to her only child. I also wanted to give him his first taste of backpacking in an area that had been a favorite of mine two decades ago, before the Forest Service had started issuing position trackers and fining people who strayed from their itineraries.

The first time I'd suggested a minor change in plans, Donnie had been so uncomfortable with the idea that I'd abandoned it. It didn't matter that I was willing to pay the fine for both of us or that I was suggesting the environmentally benign substitution of a little-visited ridgetop for an overused lakeshore. We would be breaking the rules, and when it came to that, Donnie was just like his mother. Most people obey rules because they agree they're a good idea or because they don't want to get caught breaking them. Dianne obeys them simply because they're there. Even when we were children she'd been that way, and she'd raised Donnie to be just like her.

Hence the knee. As long as he didn't figure it out, Donnie wouldn't have to join me in lying when we turned in the tracker and I tried to sweet-talk the ranger into returning my full deposit despite minor discrepancies between the tracker and the itinerary on our permit.

Of course, I'd once been just like my younger sister, but look where it had gotten me: middle-aged, divorced, a loner who doesn't mind camping in a lava flow half a mile from water.

Donnie chose to fetch water from the stream rather than using the stove to melt snow. Probably he wanted to save battery power for his sat uplink, but I suspected that he also wanted to explore. At his age, I too would have been overwhelmed with curiosity to see what was beyond the next bend. But even if middle age hadn't brought a truly arthritic knee, it had made me more willing to save tomorrow's pleasures for tomorrow, rather than trying to do everything today.

While he was at it, Donnie offered to take the position tracker with him so the machine would think we'd only paused here briefly. "I'll hang it in a tree where we can collect it in the morning," he said. "But I really don't like doing this."

It didn't look like rain and I didn't feel like pitching a tent, so I threw a tarp, foam pads, and our sleeping bags on the ground and pronounced camp to be complete. My bag was old-fashioned Polyfill; Donnie's had a selective-permeability liner that would probably keep him dry in a monsoon. But so far, he'd never tested it outside the confines of his InstaPitch bubble dome. Dianne had spared no expense equipping him with all of the latest gadgets, and I was concerned that in making sure her son was comfortable, she'd insulated him from truly experiencing the backcountry. With the image visor and the satellite uplink for his comp, he might as well be in her backyard, tethered to his home computer by a microwave link—especially at open campsites like this one, where he was assured of a good sat link. Perhaps the trick knee had been a bad idea. On the other hand, maybe our airy perch would encourage him to forgo the psychological cocoon of his bubble tent to sample the joys of sleeping beneath the stars.

I laid the stove on the flattest rock I could find, set our dinner makings beside it, and draped the solar net over another rock to top off the batteries before sunset. Then I bled a little air pressure from my boots to give

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my feet wiggle room now that I didn't need ankle support for hiking, and settled back to wait for Donnie's return.

The view from our campsite covered a 180° panorama, although initially my eyes were drawn mostly to the west, where the late afternoon sun backlit range upon range of mountains—a confusion of ridges and valleys that looked like a child's drawing of what mountains are supposed to look like. They were the Western Cascades, an older range that most people think are merely foothills to the taller snow cones of the High Cascades. A prominent valley cut a notch through them, revealing a serrated horizon that must have been a hundred miles away.

As always happens when I sit silently in a high place, my mind soon left the horizon to drift across the valley at my feet, soaring and diving over the lava flows like a hawk plying the thermals. Our lava flow, I concluded, was middle-aged like me—young enough to be spiny and as black as the bowels of the earth, old enough to support a scattering of pines and firs. Below our campsite, it fell away steeply at first, then leveled into a swirling pattern of tree-studded mounds interspersed with greenish-black flats where cinders had drifted into depressions that now sprouted hardy, widely spaced plants. The entire surface was spattered with snowfields—white against black, like inkblots on a reverse-colored Rorschach test.

I was carried back to the first time I'd ever seen mountain snow. It was in the Tetons, some thirty years ago, on my last vacation with my parents, when Karen and I were already engaged, although we wouldn't be married until the following year. In classic American style, the four of us—my parents, Dianne, and I—had made the trip in two days from our St. Louis home. Partly, we were celebrating the fact that I'd just completed my third year of college with a nearly perfect A average—a sure ticket to almost any medical school in the country, making my father beam with pride.

It was a difficult trip for me—an odd mix of childhood and independence, as I struggled with being an adult son on a vacation that was more my father's than mine. One day we compromised when my parents and Dianne wanted to take a tram to the top of a mountain. I preferred to visit the upcountry in a different manner, riding a water taxi across a lake, then hiking half a dozen miles up a canyon on the far side.

It was a decision that changed my life—a conversion experience that imbued me with a love of the high country that's persisted ever since. I don't feel truly alive unless I spend at least a week in the mountains each summer. But it might have changed my life in more ways than that if only I hadn't been quite so rule-abiding. Maybe that's why today I chafe so much at permit restrictions.

I'd hiked many times before, but never alone, and never in the West. From the water taxi landing, I climbed toward the head of the canyon, seeking a lake with the appealing name of Solitude. Halfway there I hit snow but continued, despite soggy tennis shoes, into a fairyland of winter-in-July. Soon, I was walking on continuous snow, leaving it only every quarter-mile or so to warm my feet on exposed rocks. When I got to the lake I found it frozen, ringed by snow-streaked cliffs. But the reflecting-oven effect made it warm enough for sunbathing in T-shirt and shorts. I stayed, basking, until I knew I'd have to hurry to make the last boat back to my waiting family.

It was on the way down that I met

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the girl. "Woman" I should say today, but thirty years ago I could no more think of a female my own age as a "woman" than I could imagine the person I am now, older than my parents were back then. She was hiking by herself, something no woman I'd known would even have imagined doing.

We had a five-minute talk that simultaneously seemed to stretch for a glorious forever and was over in a flash—a fleeting eternity from which I would never recover. I was both intimidated by her and drawn to her like I'd never been drawn to anyone before or since. She was beautiful: tanned, athletic, auburn-haired, and exuding a self-assured sensuality that made me lightheaded just to be near her. Even more overpowering was the sense that we shared something unspoken deep in our souls, something to which I could not then have given voice but which I knew I should learn more about, before my marriage.

The fleeting eternity stretched, then snapped. She was heading for Lake Solitude and had asked every imaginable question about route, snow conditions, distance—stalling, just as I was. She ran out of questions, and we stood there for a long moment, a silence that was expectant, not awkward. Every fiber in me cried out to respond to the unspoken invitation; it would take only an hour or two to turn around and climb back to the lake with her.

But if I did, I'd miss the water taxi. If I hadn't absolutely *promised* that I wouldn't be late, I might have done it. It wasn't really that far to walk around the lake rather than take the boat, and she was carrying a flashlight, so there was no danger if we didn't get back before sunset. But I couldn't imagine my parents' reaction. Or rather, I could imagine it all too easily. My mother would panic, trying to call out Mountain Rescue as soon as I turned up missing. When I finally showed up unharmed, she might forgive me but my father would hide his fear in anger, mostly on her behalf. And they would both know that I had deliberately chosen not to keep my word, all for a girl I would probably never see again. Not to mention that I was engaged to someone else. I turned away and hiked back down the valley, as joy leached from my soul.

I heard a crunch of cinders and had busied myself hooking wires to the stove by the time Donnie drew near. He took in the lack of tents without comment, scratching absentmindedly at a mosquito bite. Another of Donnie's gadgets was an electronic insect repeller that emitted some kind of signal—ultrasonic, infrasonic, magnetic, he wasn't quite sure—guaranteed to keep pests at bay. It had worked beautifully until he'd uncovered an unfortunate design flaw by snagging the power cord on a low-hanging branch.

"So how was the meadow?" I asked. He'd been gone a long time for so short a trip.

"Buggy," he replied. "But otherwise it was nice, so I stayed a while." He rummaged in his pack for the notebook he'd been using as a journal when there wasn't enough power for his comp, and sat down on a rock. Right now, there was more than enough sunlight for the thought logger—plus battery power to run it for a couple of hours after sunset without sacrificing hot tea in the morning—but he seemed satisfied with pen and paper, and soon was filling pages with a neat script whose contents I wouldn't dream of asking about.

As long as Donnie wasn't using the power, I hooked the water bottles to the solar net and switched on the ion-

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izer and micropump that would top off their ozone disinfection chambers. The bottles still had enough ozone for tomorrow, but I've hiked in enough cloudy weather that I always capitalize on sunshine when I have it. You can generate power on cloudy days, but it takes forever. Donnie continued to write. I'd never seen him so pensive before, but I decided to give him his space, to the extent our cramped campsite allowed.

By the time dinner was ready, the sun was nearly touching the horizon, filling the valley with a golden glow and turning the western vista to bands of orange and blue where shafts of sun slanted between the summits of the Western Cascades. Donnie was sitting on a rock, facing the sun, the light reddening his face and legs with the temporary appearance of sunburn. A hummingbird zipped from nowhere to hover a foot from his chest before deciding that his magenta T-shirt wasn't an oversized flower and vanishing as mysteriously as it had appeared. All day, Donnie had been buzzed by hummingbirds, attracted by that bright-colored shirt. The first time, he'd yelped and swatted as though the bird was a giant insect. Now he merely flinched and reached for his plate. "It's hard to believe we're more than halfway through," he said between bites. It was the first time he'd spoken since he'd sat down. "I can see why you like this place. But there's one thing lacking about this campsite." He squirmed uncomfortably on his rock. "Sitting on this stuff is like sitting on a bed of nails."

I laughed, but Donnie had finished his meal and was returning to his journal.

I wiped the plates clean with snow, then decided Donnie had brought enough water for me to sponge the worst of the grime from my face and arms. The domestic chores brought up memories of another life, long past, spurred perhaps by my earlier thoughts of Lake Solitude. Or perhaps it was because Donnie reminded me so much of myself at his age, both in his structured personality and his immersion in a lifestyle that he might never have critically examined. And his tacit acceptance of sleeping under the stars was a sign that he too might be receptive to the drama and intimate beauty of the mountains.

Usually I come to the high country to avoid memories. But now, they came like mosquitoes, annoying pinpricks that raised welts of emotion the passage of years had masked but not dulled.

The real mistake had been going ahead with the wedding. Even then, deep inside, if I'd known how to look for such knowledge, I would have realized that the relationship was deeply flawed. She'd been my first true girlfriend, a high-school sweetheart who'd followed me to college. But what she really wanted was to be married to a doctor. And when, near our second anniversary, I'd decided medical school was my father's dream, not mine, I realized I'd wedded a reflection of him, trying to win the approval he'd sometimes been slow to bestow.

What Karen loved was an image of me, not me. By the time our marriage sputtered to an end, far too many years later, I realized that even in small ways she was always pushing me to conform to that image, convincing me I was a failure simply for wanting to dream my own dreams. One of the things she'd resented were my periodic jaunts to the backcountry in which I sought refuge ever more frequently, not only because I needed the undemanding company of peaks, meadows, and flowers, but simply because she had no interest in accompanying me.

The girl in the Tetons had become

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more a symbol to me than a real woman. I doubt if I'd even have recognized her if I'd bumped into her a month later. But I thought of her frequently, beginning shortly after I was married, secretly wondering if hiking with her would have taught me that there was a whole different breed of women out there. Maybe, maybe not, but she represented a rare, important opportunity that I'd deliberately passed up, even if my reasons for doing so seemed overwhelming at the time.

The light was fading and the air was already chill. I'd cleaned the dishes and my body, but had done little for the scars of memory. Time to bury them again, if I could.

Donnie was already arranging his sleeping bag, still not his usual talkative self. Nor had he switched on his comp. Normally, his face would be awash in its pale green backlight as he busied himself in the e-mails and thought messages of a life in which distance was meaningless so long as you had an uplink. Now he was merely a shape in the darkness beside me.

I sat on his rock for a last look into the valley, moving gingerly because he'd been right about its bed-of-nails texture. The temperature was dropping and the mosquitoes were abating as they sought shelter from the chill. By the time we bedded down, we would be undisturbed by bugs. In the lowlands thirty miles away, lights sprouted, but the mountains were untouched by signs of humanity. Even the distant clearcuts were shrouded, as valleys filled with night and the panorama flattened to a sweeping silhouette along which I could make out five major peaks against an afterglow of orange, red, and aquamarine. Years of backpacking had made these mountains into my closest friends, and even in silhouette I could recognize them at a glance: Mt. Washington, Three-Fingered Jack, Mt. Jefferson, Mt. Hood, Mt. Adams, and maybe even a hint of Mt. Rainier peeking over Adams' left shoulder. The first three looked the largest, but Hood and Adams were actually taller, diminished only by distance.

There was peace here, and gradually it came to me, even as the breeze began to raise goose bumps. There was still enough light that nearby landmarks—rocks, sleeping bags, packs—were easy to discern, as were the inkblot shapes of snowfields on lava. But everything in the mid-distance was hugged in shades of black that gradually deepened to blur out all detail.

Eventually, Donnie spoke again. "What's the longest time you've gone without a sat comp, Uncle Will?"

I glanced sharply his direction but answered with a laugh. "About ten years. They weren't around when I was born."

Donnie chucked softly. "Yeah, I guess not." He was quiet for another moment. "Tonight was the first time I've ever done it deliberately." He kicked off his shoes and squirmed into his sleeping bag. "Why do you come to the mountains so often?"

"What do you mean?" I asked, suddenly cautious.

"Well, I've heard you talk about relaxing, enjoying the solitude, getting in touch with nature—almost a spiritual kind of thing. But is there something else? Maybe something like what marathoners do? You know, testing your physical limits? That kind of thing?"

It was an odd question, since we'd actually been hiking at a leisurely pace. I wondered if I'd been playing up the knee thing too strongly, making it seem as though I was pushing myself through incessant pain. But still, I was relieved that he'd qualified the "why" in athletic terms. Initially, his query had brought a pang of

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something else, close beneath the surface, something that seemed far more important than I cared to admit, even to myself.

"Not really," I said, though it felt like a lie. "Why do you ask?"

"Oh, I was just wondering what you think of people who do trips at least partly for the challenge."

"Like those who hike the entire Pacific Crest Trail?" The trail runs all the way from Mexico to Canada and there are people—probably several hundred a year—who hike the entire 2,600 miles in a single summer. Others do it piecemeal, over the course of decades.

"Sort of. Yeah, people like that, I guess. Or people who might hike only for a few days but cover a lot more terrain than you do."

I shrugged, then realized he couldn't see it in the gathering dark. "That's their choice. I'd love to be the type of hiker who could tromp through twenty miles and 5,000 vertical feet and call it easy. But the blisters would kill me. A long time ago I quit trying to do everything and accepted my limits."

"So you don't approve."

"No, not that. There was a time when I fantasized about hiking from Mexico to Canada. I'm just too old for that now."

"Older people than you—" he started, then shut up. He zipped his sleeping bag tighter against the draft. "See you in the morning." He paused. "Thanks." Another pause. "For bringing me here."

I settled into my own bag, lying on my back. Donnie's questions had touched yet another nerve, and I lay awake for a long time, as the night grew black in a way it never does in the city. Gradually, my periodic flights to the backcountry took on a new pattern, and I realized that deep inside I was looking for an auburn-haired girl to come and rescue me. Only this time I wouldn't turn her away. This time I would say to hell with the rest of the world and follow wherever she led. I'd had plenty of experience saying to hell with what other people thought. But I'd never had another chance to follow.

How often, I wondered, had I allowed inertia, fear, and commitments to be my guides through situations that could have been—perhaps that were intended by some higher power *to* be—life-changing opportunities, without ever reaching for them when they were within my grasp?

Overhead, in a cold, moonless sky, the stars shone sharp and brittle. As I stared heavenward, it seemed as though only the most minuscule force held me to the ground, as though if I did not concentrate on remaining affixed to the earth I might fall outward into space, there to spiral endlessly through a diamond-studded void of stars.

It wasn't an unpleasant sensation.

Donnie was up early the next morning, handing me a cup of tea just as the sun topped the horizon. It was a surprise. Just as last night's quiet had been out of character, normally it was me who had to pry him out of his sleeping bag. Usually, he'd sleep halfway through the morning if I let him.

He had his equipment packed and was practically prancing to get on the trail by the time I finished my tea. Even more surprisingly, there was no sign of the visor or of the antenna of his comp, which normally poked a foot or so above the top of his pack. "I decided to do without it today," he said, reading my gaze. "Let's eat breakfast down by the creek. There's a really nice view from the meadow. Do you mind if I go ahead and meet you there?"

I didn't see any harm in that, and I was definitely going to be slow get-

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ting started. Once I'd finally fallen asleep, I'd slept hard, pursued by strange, disturbing dreams in which I was trying to find something terribly important, but was never quite sure what it was. Even now, I was having trouble separating dream from reality, and kept having to persuade myself that there was nothing out there to chase after, that it had only been a dream.

"Sure," I said. Then it was my turn to hesitate. "As long as you're not using it, do you mind if I borrow your comp?"

Donnie shot me a questioning glance but surrendered the instrument without comment. "See you in a few minutes," he said.

The thirty-year-old memory log was nowhere nearly as sharp as I expected. Rather than a photographic image, it was an impressionistic rendering: lush meadows clinging to mountain battlements, icy water sparkling from riffle to pool, snow so blazingly white it was a miracle I hadn't gone snow-blind. The early thought loggers had been heavy on emotion, light on technical accuracy.

But the log was still there, in a private, archived file—a file whose name I still remembered even though I'd never before dared to open it. Conscious that I didn't have endless time, I fast-forwarded through the ascent, pausing for one heart-stopping instant when the simple act of paying the water taxi fare had opened my billfold to a photo of Karen and I simultaneously felt my long-ago glance at it—surprisingly devoid of feeling—and my current knowledge that not far in the future that woman would make my life a living hell. Even then, I could now see, my love for her was being replaced by doubt. I'd married her for the same reason I'd not hiked back to Lake Solitude: because I'd promised to do so and could imagine no alternative.

The girl appeared right on schedule, and I could feel the flash of attraction, nearly as strongly in the log as in my reliving of it. She had a heart-shaped face, almond eyes, a strong but petite figure, and hair that spilled below her shoulder blades. She wore cutoff jeans and an off-the-shoulder top that I had studiously tried to ignore, even as a tiny insect trekked, unfelt by her, across her shoulder to disappear beneath her neckline.

No wonder I'd never had the heart to play back this memory. There really had been a brief instant when I'd seen it all: that Karen and I were wrong, that the unspoken invitation was real, and that I'd be a fool not to accept it. And then I'd done my duty anyway and rushed off to catch the water taxi—suppressing that flash of foresight as ruthlessly as I'd squelched my thoughts of that enticing insect.

Donnie had a forty-five-minute head start before I finally shouldered my pack and rounded the bend to begin the steep descent to his meadow. As I turned the corner, the snow-patched summits of two of the Three Sisters sprang into view.

The Sisters are a trio of 10,000-foot mountains that are Oregon's third, fourth, and fifth highest peaks. They're part of a family grouping of volcanoes, where lesser peaks sport such names as The Husband, The Wife, Little Brother, Bachelor Butte. The Sisters themselves are generally referred to simply as North, Middle, and South, but some maps, inevitably, designate them as Faith, Hope, and Charity.

A small creek threaded the meadow below, with a six-foot post marking a junction where a trail climbed from a valley to the west. Two backpacks were leaning against the post, while nearby a pair of figures were

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taking down a small, blue tent. One looked suspiciously like Donnie.

By the time I got there, the tent was packed away. Donnie and the other backpacker were sitting by the creek, sharing handfuls of granola. His companion was a young woman who seemed to be traveling alone. Other than a position tracker dangling from a D-ring on her pack, her gear was remarkably retro—no telltale aerial for a sat comp, no solar net lying in the sun. The corner of what appeared to be a printed map peeked from a pocket of her pack, and her boots showed no valve for an inflatable air collar. This was one hiker who'd chosen to do things very much the old-fashioned way.

When he saw me, Donnie seemed just as impatient as he'd been at dawn. "At last," he said, even before I'd set down my pack. "I was beginning to think you'd gone back to sleep."

He turned to his companion. "Uncle Will, this is Andrea. She's hiking to Devils Lake." Which was where we'd be meeting Dianne three days from now. Donnie's antsiness this morning was explained. He'd met her when he'd gone for water last night, and had been eager to get back here before she moved on.

But there was more. "She came up from Frog Camp last night." He gestured toward the side trail coming in from the west. "That's somewhere down there. She's a student at the university and she's out for a long weekend. Tonight she's heading for Green Lakes. Tomorrow, she's climbing South Sister and staying at Green Lakes again."

I was impressed. "It's at least twenty-five miles to Green Lakes." And it didn't seem to be on the shortest route to Devils Lake. In fact, it was way around on the far side of South Sister.

Andrea spoke for the first time. "Not the way I'm going. I'm cutting off-trail across the basin between Middle and South Sisters. It's only an extra 1,000-foot climb and it'll save several miles."

I nodded. When I was younger, I'd hiked all over the Three Sisters Wilderness, but that was a shortcut I'd never attempted. Still, it should work. The terrain wasn't all that steep and it was high enough to be mostly meadows, where route finding would be easy.

Donnie wasn't finished. He stared at his feet, then looked helplessly at Andrea. "Uncle Will," he said at last, "I'd like to go with her."

"Sorry, I'm not up to anything like that," I said. "Even by her route it's got to be twenty miles."

"I know. But what if you took the trail and caught up with us tomorrow night? Or even the morning after?" He groped for words, his hands flapping before him like fledgling birds. "You can keep the sat comp," he added hastily. "And it's not that I don't like your company. You've always been my favorite uncle." He only had one other, but I let that pass. "It's just that . . . well . . . she's . . ." He glanced her way again and sputtered into silence.

It's just that she's unlike anything you've ever encountered before, I thought. *And you know you've got to find out more.* I looked again at Andrea, hiker to hiker. She might have skipped the high-tech toys, but her pack, boots, and clothing were top of the line—not new, but the well-used equipment of someone who was experienced, competent. I had a feeling she'd been tromping the wilderness since she was very young. Her body language implied the same, a no-nonsense poise that said better than words that she knew how to take care of herself. Physically, she was only about 5'4", but she looked strong, with arms and legs a little too

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well muscled for high-fashion beauty, which only added to the aura of competence. Her skin showed the functional tan of the dedicated hiker—not a uniform beach-perfect bronze, but a coloring that was darkest on the calves, front of the thighs, face, and upper arms, where the high-altitude sun gets its best shot at you. She had blonde hair. Well, you can't have everything.

Donnie presented the opposite picture. His clothes and pack were good but new, just beginning to show their first scuffs. Physically, he was tall and gangly, with fair skin that burned rather than tanned. But I knew he was a reliable, level-headed hiker. He might slow her down, but he could go the distance. He was, in fact, stronger than I'd been at his age. But his mother would never forgive me if I gave my assent. Donnie might be eighteen years old, but he was still her little boy, and she'd placed him in my care. She'd never understand.

Donnie seemed to read my mind. "No need to tell Mother about this," he said.

I nodded. As far as I knew, Donnie had no serious girlfriend, was not on the verge of marrying his own Karen. But sometimes you have to seize the opportunities when they are within your grasp, even if they aren't your own. And what Dianne didn't know wouldn't hurt her.

"Okay," I said. "Green Lakes isn't that far out of the way. I can meet you there. But we don't have a permit." Green Lakes was the one place where permits were the most important. Going there without one was asking for a fine.

"Andrea and I figured that out while we were waiting for you," he said eagerly. "She's got a permit. It doesn't say how many people are in her group. I can join her tonight; we can add you to the group tomorrow."

I nodded again. It was time to at least pretend I was still in charge of our little expedition. "Okay. Here's what you do. Green Lakes is a cluster of lakes, but one is much larger than the others. I'll look for your tents at the south end of that lake, tomorrow night." I made sure the plural on "tents" was well heard. There are a lot of things about which I still agree with his mother. Though as a practical matter, Andrea's tent hadn't looked big enough for two—no bigger than the pair of tiny tents Donnie and I'd been forced to carry because I'd hiked alone for so many years I no longer had a decent two-person one.

Now that he'd gotten what he wanted, Donnie had an attack of the guilts. "What about your knee?" he asked. "Will you be okay on your own?"

"Donnie, I was solo backpacking when you were in diapers. I'll do fine." I tried to look serious, but I could feel a grin forcing its way to my lips. "Don't worry, the knee won't be a problem. You and Andrea have a good hike. Climb South Sister with her if you feel like it. It's steep but non-technical. I'll be there by the time you get down."

Even though Donnie and Andrea had a long way to walk, it took another half-hour to get them on the trail. First, we had to pull everything out of both Donnie's pack and mine, reorganizing our gear for separate travel. If he forgot something, Donnie would do fine with Andrea, but I didn't want to discover the hard way that he had all the dinners while I had the lunches. Andrea was patient, clearly aware of the necessity of what we were doing. If she hadn't been, I'd have been very wrong in my assessment of her competence.

When they finally helped each other into their packs and buckled their hip belts, I grabbed a couple of granola bars for a belated breakfast and

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started out with them. For the first several miles their route was the same as mine.

At first I found it easy to keep up with Andrea's deceptively leisurely stride, and I caught myself wondering what it would be like to accompany them all the way to Green Lakes. That was a surprise; it had been years since I'd been drawn to anything that adventurous. In fact, I'd abandoned off-trail travel entirely, mostly because it's safer to stay on trails when you're on your own. I began to wonder why, prior to this outing with Donnie, I'd given up seeking backcountry companions.

But along with the off-trail hiking I'd also abandoned the jogging that had once been part of my training. As we started up the first substantial hill, I had to work harder and harder not to lose contact with them.

In a supposed effort to lighten his load, Donnie had foisted off his electronics on me, including the useless bug repeller. They weren't actually all that heavy; getting rid of them had been a transparent effort to impress Andrea, who'd wisely pretended to accept the nominal excuse. When it comes to carrying a few luxuries on a backpacking trip, there's actually no right or wrong choice—some people insist on packing gourmet foods and fine wine on weeklong trips. Once, a young man walked by me carrying a gigantic watermelon lashed to the top of his pack. A few moments later, his buddy came by with a large Styrofoam ice chest. If those guys really wanted to carry all that weight up a mountain, well, all I could say was better them than me.

Gadgets are a bit different. Technologically, Andrea was at one pole of the spectrum. Until now, Donnie had been at the other. Me, I'm in the middle. I like the solar stove, even though keeping the battery charged is a nuisance. If nothing else, I can carry it on an airplane without setting off a bomb detector. Similarly, the ozone bubbler weighs less than a water filter and gives nearly as good-tasting water. And I love the air boots—although Donnie's experience with the bug repeller made me wonder what would happen if I broke a valve or lost the CO_2 cartridge that inflated them.

Despite its return-to-nature claims, backpacking has always been a high-tech sport; even Andrea's pack was made of lightweight materials that would have been viewed as miracles not all that long ago. I wondered what she'd think of Donnie's high-tech tent, which weighed only two pounds and snapped into shape with a quick shake. Still, Andrea was less dependent on things you can't fix in the field. The map visor is a wonderful device, but with it, Donnie was never more than a power failure away from not knowing where he was.

To my surprise, though, I now found myself playing with the visor, plotting the elevation profiles not only for Donnie's route but also for mine. If Andrea struck the obvious traverse, her route was actually a lot flatter than mine, which bounced through several drainages radiating from the big peaks I would be skirting. Briefly, I entertained the idea of following her at my own pace, but Donnie needed to do this by himself.

Having activated the comp to use the visor, I couldn't resist taking another peek at my memory log. This time, I started with the girl—earlier, I'd bookmarked her position in the file—and played the encounter all the way through to its inevitable end. Then, I rewound the file and froze the image at the point where she was just beginning to move up the trail. She was turning to go, looking at me across her shoulder as she brushed a strand of hair back from her eyes, the afternoon sun streaking it with high-

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lights the color of burnished bronze. The unspoken invitation was at peak intensity.

Was she really as lovely as I remembered? I couldn't be objective, even when I suppressed the emotional replay and focused on the visual. Not that it mattered. She'd always *felt* like one of the most appealing women I'd ever met, and in the replay, the only thing that had changed was that she looked incredibly young. What had happened to the once-young man whose feelings I was so vividly reliving?

With a sigh, I fast-forwarded again, planning to jump to my reunion with my parents. Then I hit the pause and stared in amazement as a familiar figure appeared on the trail, about a mile before the water taxi.

I had forgotten that Dianne had taken the water taxi across the lake to meet me. But now, faced with the evidence of the log, the memory came flooding back. She'd been so excited to meet me, chattering eagerly about the wonderful day she and my parents had had, asking me to tell her all about my own hike but not giving me time to do so even if I'd been in the mood. She'd never noticed that I completely tuned her out as we hurried to the boat, catching it with scant minutes to spare.

I resumed the playback, dimming the visual and concentrating on the emotion log. Instantly, I was staggered by an onslaught of conflicting feelings. On the one hand, my mind had been emblazoned with the image, already fading to an impressionistic gestalt, of unruly hair and a lingering backward glance—the sad certainty of an opportunity come and gone. Opposing that was an overload of guilt as I realized that if I'd not come back on schedule, Dianne would have kept looking for me until she too missed the boat and found herself stranded on the wrong side of the lake. She was in no real danger, but the emotion log said it all: I'd felt that I'd nearly betrayed my baby sister. Even if I could have faced my parents' disappointment, I could never have withstood my own.

I'd had enough of the log, so I switched it off. Donnie and Andrea were now twenty yards ahead, and as best I could tell, I'd hiked the better part of half a mile with so little attention to where I was going that I might have walked into a tree.

That's the main problem with electronics in the wilderness. They pull you too easily out of the world you're supposedly there to visit. If I wasn't careful, I'd wind up reading my thought mail or checking in with the office to see how it was faring in my absence. Just to be on the safe side, I shut the comp down completely and for good measure pulled off the visor and let it dangle from my neck by its strap.

And yet, I was happy I'd used the comp. Because suddenly, everything made sense. All those years ago, I'd been hit with two conflicting messages: the lure to break free and a reminder of the cost of doing so. It wasn't all that different from the decision I'd been forced to make about Donnie, but it had taken thirty years for me to learn that there are no easy answers.

The day was warming rapidly, and a few minutes later, when I stopped to peel off a layer of clothing, I stuffed the comp and visor deep in my pack.

Donnie noticed that I was no longer following and turned back for a quick farewell wave. His face was alight with adventure and unlimited possibilities. "See you tomorrow!" he called.

A moment later, I was alone, as I'd been so many times before. But this time was different. The aching void of "what if" was no longer with me,

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and I realized that the true heartache hadn't been regret, but fear—fear that I was doomed always to walk away from those rare, life-changing opportunities, that I would never have the freedom or the courage to accept them. For years, that had kept me from committing myself to anything.

Now, I knew otherwise. Dianne might be furious if she ever found out about Andrea, but it would be worth it. I smiled, realizing that in risking the best thing for Donnie, I'd inadvertently done the best thing for myself.

Once I'd slowed down to a comfortable pace, the walking was easy. By backcountry standards, the Pacific Crest Trail is a turnpike, the rocks ground to a fine, foot-cushioning powder by the passage of thousands of hikers and horses. Before me, the trail stretched 2,000 miles to Mexico. *Maybe someday*, I thought. *Maybe someday.* ■

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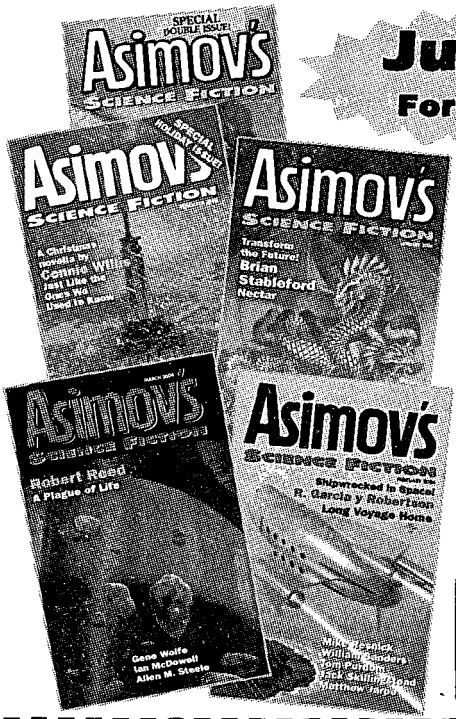

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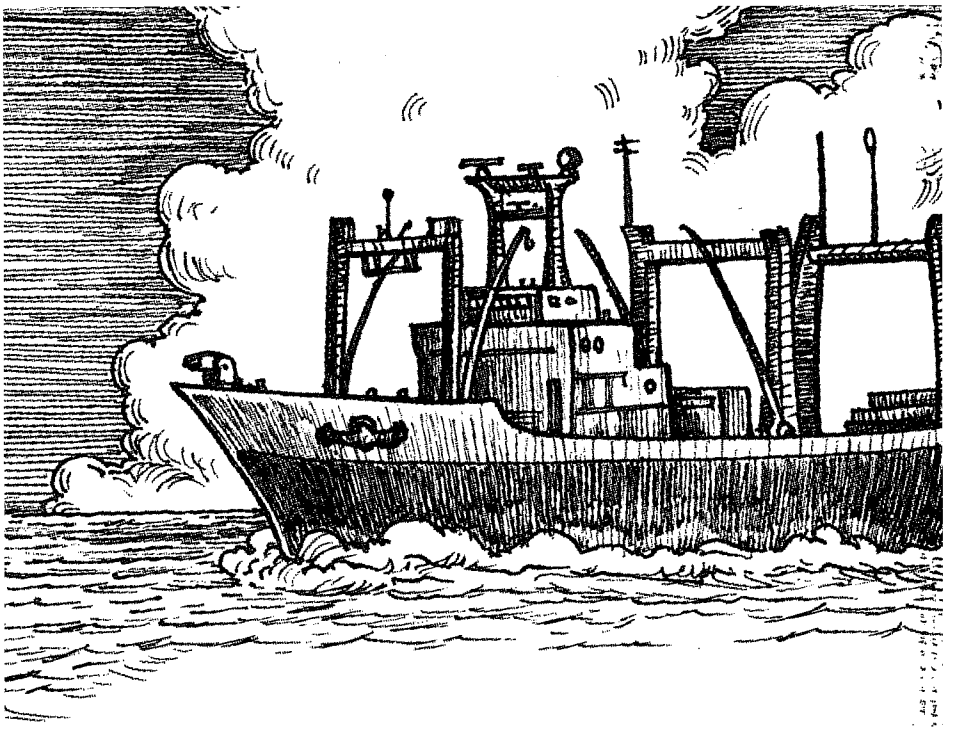

Harpoon

G. David Nordley

Illustration by Wolf Read

There are two sides to every story—at least.

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Erikka Nilsdotter first spotted her prey on the radar, then swung her binoculars in its direction. There it was! Huge, low and gray on the horizon. She sucked in a breath and felt her heart race. *This*, she thought, *must be how Captain Ahab would have felt!* She punched the sonoblaster button, and felt, rather than heard, the ship vibrate with what they hoped signaled "danger." Near them, the huge sperm whale they'd been marking breached so high she could see the sucker scars on its jaw and then it sounded, its huge tail falling off to the right as it slid majestically below. A cheer broke out among the crew of the ESPS *Bardot*, and Erikka raised her fist and sang out, "Dive, friend, dive!" in a voice that cut through the hiss of the sea and clatter of gear with operatic force. Round one to them.

Now for the dangerous, exciting part. She wiped the smile off her face; control was important. No one should see how stoked she was, lest their opponents accuse them of doing what they did for the fun of it. She turned to the tall, thin, blond-bearded, bare-chested eco-warrior beside her.

"Reef the sails and pull up the boards, Marc, then full ahead. We'll block them port if we can. The whale went off that way, bless'm, and more likely than not it'll surface in that direction, if it hasn't gone deep to feed."

Eager Earthsea Warriors jumped to their winches and, one by one, genoa, main and midden sails vanished into hollow booms. The turbine's hum became audible and slowly built into a scream; it had belonged to a tug once, but on the *Bardot,* it had a different gear train and a different prop. The port side board rotated up, out of the hissing foam.

The *Bardot*'s stern sank, then began to rise again as its shallow draft began to spank the waves and wind of their passage set the sail rigging to song. Erikka wondered what the target whaler's crew thought as they saw their unlikely contraption heave itself out of the sea and crash and heave again.

"They're going for the whale, winding the props up," the soundman sang, clasping his headset to his ears with his hands in an apparent effort to keep out other noise.

Erikka hit the horn for two short blasts and cranked the wheel counterclockwise. They would say the *Bardot* was technically overtaking and altering her course to avoid hitting the other boat's stern. This would put them technically in the right, though they knew damn well where the other ship wanted to go and that their maneuver was putting them in its way before it could even begin its turn. The thing to do was to make it look as if the whaler was turning into *them;* in an inquiry or public debate, people would believe what they saw. "Fenders out!" she shouted. "Dinghies! Cameras!"

Thirty old half-tires nailed to a fifteen-meter beam laminated from redwood planks jumped over the side at the urging of eager hands and thunked against their starboard side. Thrills were great, but they should be survivable thrills, and this would be the *Bardot*'s thousand tons of displacement versus her opponent's twelve thousand. Erikka reached for the mike and flipped the other switches, too; what she said now would go out on PA and the recorders as well as channel 16.

"Whaling ship *Marianne*, you are hunting an endangered species and endangering us as well. Stand on to starboard."

The larger ship ponderously began to bear port, toward the whale. Erikka altered port to match, still heading for a spot between the whaler and where the whale had sounded. The *Bardot*'s bow had been reinforced to take an impact, and her wide bottom would tend to slide rather than roll, but a glancing blow was still much less dangerous and would look just as good to the cameras.

She hung on as the *Bardot* crossed the whaler's stern wake and slid into the trough behind the bow wake, the power of her engines keeping her well in hand.

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The courses converged on a point between the whaler and the whale's last position. To make it look good, the *Bardot* had to get there first. She looked up and saw that Marie was out on the bowsprit with a camera, getting the best angle possible, her dramatically long hair flying and her t-shirt plastered against her figure in a way that she probably hoped would distract the other ship's crew.

Erikka smiled and shook her head. Marie laid it all on the line, everything, all the time. Then she frowned. Marie wasn't wearing her life jacket.

Erikka slapped the radio toggle off and keyed the mike. "Someone get a life jacket forward to Marie. Anyone who isn't wearing one, get one on, *now*!"

Someone touched her arm. A quick glance showed it was Marc, with her own life jacket. Without saying a word, or taking her eyes off the situation, she shrugged herself into it.

They came up on the whaler's bow wake and powered through it more than over it, spray flying so high it splattered the wheelhouse windows. "Prepare for collision!" she shouted. They were pulling ahead of the other ship.

They were close enough to the port side of the whaler to see some of its crew shaking fists at them. "Get the f . . . hell out of here," a big, black-bearded man boomed at them, "get the f . . . out of here you f . . . bitch!"

Erikka snapped the radio switch up again.

They were being hailed in English with a north European accent: "Approaching vessel, approaching vessel, this is the research ship *Marianne*. You are interfering with our work. Leave the area! Approaching vessel, approaching. . . ."

Erikka keyed her mike. "Stand to your course, *Marianne*. We are overtaking on your port, giving you way starboard. Stand to."

"Get out of our way," came the response.

The words were for the record; it was too late for either vessel to do anything much. She grinned. Almost sexually aroused by the danger of the impending crash, a fantasy of martyrdom took hold of her mind. She could give herself to the cause now; a sharp turn starboard, and the *Marianne*'s bow would cleave them in two, crushing the boat like kindling, hammer its way to the wheelhouse where she would meet its final fatal blow unafraid, oh, yes, unafraid. . . . She shook herself. No, not now. Not everyone on her boat was so ready for a martyr's death. She wasn't, really. Duty called.

"Cut power, neutral as soon as it's safe," Erikka told Marc.

The turbine wound down and the *Bardot* started to settle down. The whaler finally started to turn starboard. At the last moment, Erikka wrenched her wheel port and the *Bardot* heeled starboard to take the hit with the flat side of the *Marianne*'s bow, instead of the prow, against *Bardot*'s midbeam. But the cameras would clearly show the *Bardot*'s bow ahead of the *Marianne*'s.

The impact happened almost in slow motion. The tires squished flat and the beam that supported them splintered with cracks sounding like gunshots. The hulls of both ships groaned under the enormous pressure. Marie screamed. Erikka's heart jumped as she saw the camerawoman fly from the bowsprit as the slow-motion impact accelerated the *Bardot* sideways, correcting its heel and then some, as the starboard side rose impossibly high. She caught a whiff of burning rubber as the tires scraped against the *Marianne*'s hull. Water sprayed high over the port side, but, as it was designed to do, the flat-bottomed *Bardot* finally slipped sideways and the port safety lines did not go under.

But the boat groaned audibly with the tremendous pressure of water on the port side.

"Neutral, braked," Marc said, calmly. "Camera tethered," he added with a smile.

Sure enough, Marie's camera hung accusingly from the bowsprit lifeline.

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"Marie jumped clear?"

He nodded. "I think she made an act of it. But we still have to pull her out."

Erikka grabbed the mike and briefly considered a *"M'aidez,"* but settled for:

"This is motor barque *Bardot*, thirty degrees two point four minutes south, fifty-nine degrees seven point eight two minutes east. We have been struck by another ship, have one woman overboard, and as yet unknown damage. We have ten aboard, one overboard, and unknown minor injuries. We are still afloat but hull integrity is not known yet. We are a twenty-meter motor barque, black hull with white trim and two masts. We will be listening on cha—"

"Selonce distress," a much stronger transmitter broke in. "This is Norwegian research vessel *Marianne*. *Bardot* is an Environmental Sea Posse protest boat that deliberately bumped us and is undamaged as near as we can tell. The girl overboard jumped and . . . yeah, well port of us, full ahead . . . and will climb back on after her little swim. There is no problem. *Marianne* out." The thrum of the its propellers echoed through the *Bardot* as it bumped along the side of the whaling ship.

Erikka's jaw tightened. Why is it that half-truths always hurt more than bold-faced lies? Those greedy bastards were trying to kill intelligent beings; they had no right to try to appear in the right! She gripped the microphone as if it were a weapon. "This is *Bardot*. *Marianne* struck us by maneuvering into us while we were overtaking in an effort to chase a whale in violation of international law quotas. Anyone wishing to render assistance, meet us on channel 68. *Bardot* out." She turned to Marc. "How's Marie?"

"Don't know yet."

Erikka felt the beginnings of a hard, cold cramp in her gut. The adrenaline was wearing off now and the enormity of the risk beginning to sink in. "I don't care how good the cause was, that was a foolhardy stunt."

Marc scratched his beard. "Well, we know that territory."

They stared into each other's eyes. Marc was getting close to the forbidden topic. She and her number one both knew that the line between just playing brinkmanship with martyrdom and really going for it could get fuzzy when the adrenaline started flowing. Erikka had done her share of standing on the edge of a cliff wondering what that one final, cathartic experience might be like. She would not make that choice for others, but it would not surprise her if there was enough madness in her group to crew a genuine suicide mission. And what if she was asked to captain it?

Adrenaline did strange things to the head when moral certainty justified . . . anything. She shook her head, trying to banish such thoughts. She had a crewmember overboard. She had the microphone in her hand.

"Anyone on the port side. Do we have a visual on Marie Suarez?"

The bridge phone rang almost instantly. Marc answered it.

"She's waving to us from the water, about a kilometer astern," he said.

"Great, thanks."

Erikka watched the whaling ship plow on toward where they saw the whale dive. No sign of the whale yet, thank goodness. Should they try another blocking run? How long would Marie last in these waters? The Antarctic currents swung well north in these longitudes and the water was not warm. Marie was only wearing a t-shirt and shorts. Erikka turned the wheel. "Give me ten knots," she said.

"We're going back to get Marie," she responded to Marc's questioning look.

The turbines whined and the *Bardot* began to push itself forward again.

Getting Marie meant coming about with differential thrust, motoring back to within a few meters of the her, turning the bow into the light, choppy sea, launching the zodiac, pulling her aboard, getting them all back to the ship, getting them up the rope ladder, and hoisting the

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zodiac. It took half an hour. The crew cheered as Marie climbed up over the rail.

Erikka met her and asked if she was all right.

Marie straightened up to her full 160 centimeters. Her skin was blue. "You should have gone for another block! I can tread the water for hours, and if not," she shrugged, "it is good publicity."

She pointedly ignored the proffered towels and blankets and marched, dripping, back to the bowsprit to get her camera, to applause from the crew.

By the time they were done with all that, the sound of harpoon cannon fire reached their ears. It was the better part of a kilometer from where they thought their whale would come up.

"Damn!" was all Marc said. Erikka bit her lip. Maybe it was a different whale.

"We'd better go document the butchery," Erikka said. There was no urgency now; they could save their fuel. She checked the wind direction and speed; about seven meters per second thirty degrees east of the bearing to the whaler. She brought the bow around toward their target.

"Portside board down," she called out, "and hoist the main." In a few minutes they had everything up and were making progress. As a sailing ship, the *Bardot* was compromised and had a fair amount of leeway even with the sideboard down; by bearing directly for the whaler, Erikka figured her heading would bring them a hundred meters or so off its port side; just the right place to watch the slaughter. It would turn their stomachs, but that was probably due punishment for failing in their mission. Revenge would come later when the video hit the news.

They arrived all too soon. The dead whale lay next to the ship and men scrambled over it like ants, attaching the lines that would drag its carcass into the ship's stern. She brought the bow to the wind and lowered the sails; they would hold position with the turbine as they documented the horror.

Marie—still looking like a wet t-shirt contest entry—and Barry put their big gun on the operation. The thirty-centimeter modified astronomical telescope could read a person's watch a kilometer away and hung from an actively compensated suspension fine enough to let it do just that, assisted by the fuzzy logic of the attached video camera. Erikka watched the monitor on the bridge.

"Can you believe that?" Marc said. "Those jerks have carved graffiti right into the whale's hide!"

Erikka looked. Sure enough, there was a very crude line drawing of a whale with something like a flower or a Japanese sun on its side.

"Probably meant for us," Erikka said. "But I don't get the symbolism. If it were a Japanese ship, it would be obvious, but the *Marianne* is about as far from being Japanese as you can get. Look, one of them is going over to it. Maybe to do some more."

But she saw the whaler motion to one of his comrades and point to the graffiti. The other man, hanging carefully onto the ropes that now crossed the carcass, came over and looked. Both of them were obviously surprised.

"They're just acting surprised," Marc said. "Like some of those farmers that discovered the crop circles in their fields that they made the night before."

Erikka grunted. This was a complication they didn't need. A "who's carving on the whales?" episode could take attention from the main fact of whale hunting. After a thirty-year ban, the "recovery" of sperm whale populations to mid-sixties levels and the "need" to monitor the population by taking samples had been used by whalers to allow resumption of limited hunting with research quotas. The fact that these were intelligent animals seemed not to matter.

Well, she thought, it was too late to do anything about the images from where she was; everything they were seeing was going out through the satellite dish on their stern in real time. The folks back

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at ESPS headquarters' "Restore the Ban" campaign would have to take care of spinning it.

The *Bardot* took video until the whaling ship's rear door was raised high enough to block their view, then resumed their patrol of the area. The *Marianne* was unlikely to try to take two whales and there were two more ships in the area on the satellite imagery. Those were probably other whalers, as they were well out of the shipping lanes.

Erikka ran the *Bardot* north with the wind on her starboard rear quarter, toward the last position of one of the other whaling ships. Huntress again, she scanned the radar.

Marie, with the sharpest eyes of all of them, and the least fear of heights, spotted the sick whale before the radar. Her tiny, dark body was ferociously conditioned, as might be expected of the circus acrobat she was in the off season, and clinging to the top of the waving mast thirty meters above the deck was her kind of place.

"It's just kind of lolling around," she said over her wrist phone. "Hasn't broached or sounded or done much of anything in twenty minutes."

Erikka got the bearings and, half an hour later, the *Bardot* reached the whale. The seas were a bit heavy and with the *Bardot*'s leeway, it took some tricky sailing to bring them alongside down wind of the whale. It was huge; over fifteen meters long, maybe eighteen, and clearly unhappy, dipping under and giving frequent, anemic blows from its lumpy, off-center blowhole.

"Fresh sucker scars," Marie noted. "Above the left jaw."

"I see," Erikka said. But she knew the wounds of such unequal contests were unlikely to be the cause of its distress.

"Cetacean B virus, I'll bet," Marc said. "I'll get the inoculator."

Erikka nodded. The ocean had epidemics of its own, and this one had been responsible for many whale beachings. They had a cure; an otherwise harmless bacterial infection that produced a substance toxic to the virus. The inoculator would shoot a tiny sliver full of the things deep into the whale's flesh. If it could survive another three or four days, and not be found by the whalers, it would recover.

"Jesus!" Marie, down from her perch, exclaimed, pointing to an area just behind the whale's eye. "Do you see that?"

"That" vanished beneath the waves just as Marie mentioned it, so they had to wait a few minutes before the whale rolled that part of its anatomy above the water again. When it did, Marie had her camera ready. The area was visible only for a moment and Erikka wasn't really sure she'd seen what she'd seen.

"A harpoon wound?" Marc asked, hesitating to fire the inoculation dart.

"Dunno," Erikka said. If the whale was both sick and wounded, it was a poor candidate for survival. But to Erikka, they were fellow beings. When a fellow being is on his or her last legs, you don't walk away; you try all the harder. "I'd proceed with the inoculation anyway."

Marc fired the inoculator and the prick of its dart must have stimulated the sick whale out of its lethargy. It sounded and left them staring at the waves.

"Hope it will be okay," he said.

She nodded. But what she thought she had seen unsettled her.

"Look! Through the viewfinder," Marie said and offered the camera to Erikka, frame on pause.

In the viewfinder, there was no mistaking what had been carved into the whale's skin. The crude drawing again showed the outline of what had to be the whale; a crude sideways triangle with eyes, a tail, lines for flippers and a slit jaw. It had a flower-like thing on its side with several long "petals." But this time Erikka clearly saw a long torpedo shape below the "flower." Also, there was a line sticking straight out of the "whale" as if it had been harpooned. One of the petals of the flower seemed folded back against the

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harpoon where the others stuck out straight. Silently, Erikka handed the video camera to Marc.

He looked at the viewfinder screen replay, tight-lipped, for a minute or more. Then he lowered the camera and handed it back to Marie.

"Is there any way," he asked, "that another whale could have done that? Held a harpoon in its jaw, maybe?"

No one spoke. They all, she thought, knew whale behavior well enough to doubt that idea.

"Maybe pranksters in submarines?" Marie ventured.

"How would they get the whale to hold still for it?" Erikka asked

"Robot submarines made to look like giant squid?" Marc theorized.

"In secret? We have spies in every whaling company. We'd have heard."

In the following silence, the obvious explanation, the one that she'd been avoiding, buried itself like a cold dagger of ice in Erikka's gut. The same explanation, and its implications, must have reached each of them, she thought, because Marc put his arms around Marie and she buried her head in his chest to hide her tears. Moral certitude, she mused, is like a bright shiny mirror that reflects everything the universe throws at you so that you can proceed confidently about your oh-so-self-righteous business. But God help you when that mirror shatters.

The *Bardot* approached the whaling ship the next evening. It was quiet; the night watch had probably taken over. They worked twelve-hour shifts, Erikka figured, and the few men on deck were likely looking at stars or just getting air. A day ago she'd denounced them as murderers, but that ideology was clouded now. *Murderers*, she thought, *weren't we all?*

Erikka contacted the *Marianne* on channel 16 and moved to 68. She wasn't welcome, not hardly, but they'd let her come aboard to talk rather than clutter the airwaves with chitchat.

She was met at the top of the ladder by a dark, rail-thin woman who looked at her as though she were seeing the devil herself. Erikka stared for a moment, not realizing that such ships had women aboard. She nodded to the woman and made no effort to explain herself or make other small talk.

The captain was a tall, white-bearded man who might have matched many images of the legendary captain Ahab, except for his New York Yankees baseball cap. He did not offer his hand and she did not offer hers. But he did nod to the weather display.

"Big low spinning off the circumpolar. Goin' ta be damn bit windy in a couple days."

His version of English tended to have long vowels and accents on every other syllable, but was generally understandable. That being the case, Erikka decided not to try her rusty Icelandic.

"I know," she said. "We'll be gone."

"Gone?" he asked, eyebrows raised.

She explained the markings on the whales and where they likely came from.

"Don't get me wrong," she concluded. "I'm still dead set against killing whales, at least by human beings. This isn't our fight and I don't think we do any good by getting involved and changing its rules and then changing them again."

"I just do my job, miss," he said, the Norse cadence of his voice growing stronger with feeling. "But if I think about it, we working human beings are just as much a part of nature as anything else. Those who set the rules say we can take some whales again and I have a family to feed. I have not exceeded any quota, and if some properly designated authority tells me to stop, well, then I stop. But you are not a properly designated authority."

If you saw a child getting raped, she wanted to say, *would you seek a properly designated authority? Or would you do something?* The sea breeze did not totally annihilate the stomach-turning stench from below. But for once, she

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kept her lecture to herself.

"I hear you," she said. "I didn't come over to debate. Do you have a harpoon on this boat that you can spare? The old-fashioned hand-held kind?"

"Huh?" He stared at her. She stared back. Finally, he seemed to convince himself that she was serious. "We got the spikes we use to hold things to the carcass. Pretty much the same kind of thing, about two meters with barbs on the end. Don't tell me you're going to switch sides, now? But if you are, it's just a good way to get killed in a small boat. Those sperms *are* just smart enough to know what's goin' on and they *will* turn. That's no legend and besides, you have no permission to kill."

She shook her head. "Not me."

He looked down, as if he could see through the dozen steel floors in his floating castle to the depths below where, in the gloom, whale and squid fought their ancient battle.

"You're crazy," he said after a while. "You think they'll know what to do with it?"

"Probably. I'll pay for the spike," she said.

"You and your boat leave tonight, before the storm?"

"Yes."

"Payment enough, that, I think. Luck to you, then. Sonja will get the spike. And if a whale floats up, we'll send some more down."

Redress, Erikka thought. It would only be redress.

On the way back, she asked Marc to stop rowing midway between the boats. On the horizon to the left of brilliant Fomalhaut lay the constellation of Cetus. To some, it represented a whale, a fellow warm-blooded mammal that bore live young, lived in families and sang songs that humans could almost understand. But there was an older tradition.

She took the barbed spike in her hand and tried to imagine how she would grab it if she had a tentacle instead.

For in the beginning, Cetus was not the gentle giant, but a sea monster, devourer of anything in its path. For those solitary beings far below, it had always been that way. They were beings whose descent was so utterly alien from that of man and whose behavior and society—for that must be what they had—were so utterly unknown that they may as well have come from another planet. But they could see with eyes, manipulate with arms, and imagine with a brain that were, in function, even closer to hers than those of the whale. They had taken the initiative and contacted humanity.

What flowering of *Architeuthis* culture had happened when the attacks from above had lessened? What disaster had it been when the predation had built up again? She tried to think of the courage it would take to wrap one's tentacles around the monster eating you and continue, even as your arms are being severed and the sea darkened with your blood, to scratch out on the monster's skin with your beak or a shell in a free tentacle, a plea to the gods above who had deserted you.

Whatever else human and *Architeuthis* had in common, courage would be part of it. Did they, she wonder, dream of the ecstasy of martyrdom as well?

She took some cord and tied a plastic bag to the spike, by way of a crude speed brake.

She looked back at the whaler. What that and the sperm whale had in common was that they both killed and ate other thinking beings. The squid were predators too, so they might understand. Man and squid would send pictures to each other and, eventually, she imagined, the full story would be known. But the first message was clear enough. Loosely translated it might read:

"Help us. We are dying. Why did you stop hunting those who kill us?"

She tossed the spike and watched it fade in the depths below. "Luck to you," she whispered. ■

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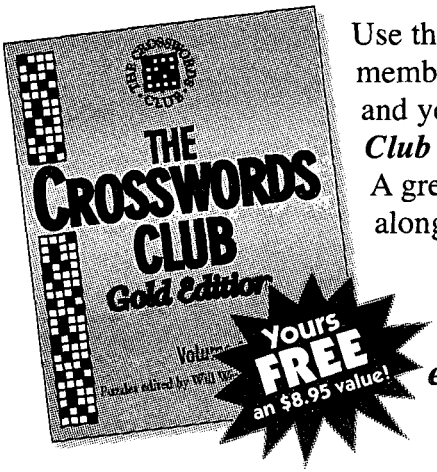

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Fore-Thought

Don D'Ammassa

"Of course, we had a number of technical difficulties to overcome before becoming operational, but we're pretty well satisfied with the results."

Alan Forrester would have thought it impossible to radiate self satisfaction while dressed in an atmosphere suit, but Dan Griffin achieved that wondrous feat. "It's certainly an impressive accomplishment, but is it really golf?" He raised an arm and gestured dramatically at the lunar landscape.

"Certainly it is. Of course, we've had to make certain environmental concessions. Each fairway is in fact several kilometers in length, to allow for the lesser gravity. We've increased the hole diameters to a full meter, proportionate to the overall playing field, and added radio homing devices so that players can locate their balls, but otherwise we've remained very close to the original concept."

"Plenty of sand traps," Alan quipped. "But no water hazards."

The two men stepped back to allow a robot groundskeeper to pass. It moved silently, outstretched sweeps stroking the lunar dust their feet had disturbed to restore an artificial semblance of virginity.

"They seem very efficient."

"There's one assigned to each fairway. They're programmed to respond to the passage of humans and restore the lunarscape to its original state. That way each player is assured an unsullied experience."

"Well, I'm impressed, but it remains to be seen if the audience back on Earth will see it the same way."

When offered the chance to become lead commentator for the first Luna City Open, Alan had hesitated. He was skeptical but recognized it as a unique opportunity. This was his chance to join the ranks of the legendary, Cosell, Madden, and others.

Or was it?

The first round was almost painfully dull, and the second was excruciating. Even with dune buggies to move the

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players around the enormous playing field, delays between shots were excessive. He'd risen in his profession because of his talent for speaking extemporaneously and entertainingly, but there were limits to even his ability to fill the long intervals. His associates were little help. Vernon Peach was suffering from unexpected agoraphobia, kept glancing up at the brilliantly clear sky and forgetting to answer questions, while Kathy Briggs chattered obsessively but without focus.

Alan imagined thousands of fingers reaching for their remotes and switching to another channel.

The match lasted five days, and the ratings steadily bled to death. By the end of the tournament, even Alan was having trouble concentrating on the various monitors that kept him updated on the status of the players.

When it was all over, he attended a post mortem with Griffin and his associates. "It's too slow," he told them. "And too impersonal. There's no tension."

Griffin made a token protest, but it was clear that he agreed with the verdict.

"I assume you'll be recommending that your network not cover our next contest," he said gloomily.

"Not as it's presently structured," Alan replied. "But I do have a few suggestions."

Henry Snead checked the display on his wrist before teeing off for the third hole in the Second Luna City Open. He still hadn't completely adapted to the lighter gravity and overcompensated, slicing to the right of the main fairway. A maintenance robot used its laser to destroy the ball in flight and Snead was assessed a one stroke penalty. As the robocaddy set a new ball in place, he glanced at his chronometer and started to sweat despite the efficient environmental controls of his suit.

Alan sat in the control booth, feeling smug and optimistic. "Snead muffed his first shot, folks, which will cost him a stroke and three minutes. As you know, he started with only one hour's supply of oxygen, and the supplementary tank will only unlock when his ball enters the hole and passes through the electronic recognition field."

He glanced at the array of monitors and cued another camera. "Back on fairway two, Gabe Nelson is down to three minutes of air and he's still twenty kilometers from his ball. And on fairway three, Caitlin Kelly has opted to enter the minefield and play from there rather than accept the two stroke penalty. Willie Bergeron lost his left hand after he made the same decision an hour ago, but chose to continue playing once the autosurgeons stopped the bleeding. Under the rules of the tournament, he can't have a replacement grafted on until this round is complete."

He glanced at the ratings monitor. They were actually gaining viewers at a fairly steady pace. He sat back in his seat and smiled.

On the final day of the competition, Caitlin Kelly had a commanding lead and there was little doubt of the outcome, but the ratings didn't waver in the slightest. Abner Morgan was in a coma, and six other contestants had been forced to drop out of the final round. The twenty-two participants had lost a total of twenty eight limbs and countless digits to the minefields, laser turrets, and other booby traps sprinkled across the course. Eleven players had been revived after being asphyxiated, one of them twice. Kelly had struggled to complete the last hole with a broken collar bone, winning by a single stroke. The final day of competition had enjoyed the highest ratings of any sports show in history.

Dan Griffin burst into the control room to shake his hand vigorously when the broadcast finally ended. "Brilliant! You're a genius, Alan. I don't know what we would have done without you."

"It would have occurred to someone sooner or later," he said modestly. "After all, golfers are used to playing with a handicap." ■

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THE SOUND OF THE BIG BANG

For the January 2001 issue of *Analog*, I wrote a column entitled "BOOMERanG and the Sound of the Big Bang." It described a then-recent Antarctic balloon flight that had mapped the small-angle temperature variations of the cosmic background radiation (CBR) and discussed the implications of these measurements for the flatness and structure of the universe. Following the lead of the scientists involved in the project, I described the temperature variations that they observed as, in effect, a recording of the "sound of the Big Bang" when the universe was 376,000 years old.

That column was published two years ago, and for some time it has been available on the web at http://www.npl.washington.edu/AV/altvw104.html. Two months ago I received an e-mail from a mother, who said that her 11-year-old son Daniel was doing a school project on the Big Bang. They had found my column on the web, and she was wondering if the sound of the Big Bang mentioned in my column was actually recorded anywhere, so that Daniel could play it for his class.

My answer was, of course, "No." However, the question caused me to consider the problem of how one might go about producing such a recording. With the available data from BOOMERanG and more recently from WMAP, it would not be very difficult to simulate the sound, using the symbolic algebra program *Mathematica* (Wolfram Research). I'm a fairly skilled user of *Mathematica*, which I use for data analysis and calculations, and it includes the feature of rendering mathematical functions as sound that can be captured as *.wav* files on a computer.

I was fascinated by the idea of synthesizing the Big Bang sound, and it ran around in my head for a day or so. I decided that I wanted to hear what the Big Bang sounded like. So one Saturday morning, when I should have been doing something else, I downloaded the frequency spectrum measured by WMAP, the satellite probe that has done a definitive job of mapping the cosmic background radiation and was featured in one of my recent columns. Then I quickly wrote a 16-line *Mathematica* program that read in the WMAP data, produced the sound as a mathematical function, and saved it to my hard disk as a *.wav* file.

My PC has a good sound card and a substantial sub-woofer, so it reproduced the *.wav* file well. When I ran the program for the first time and the sound started echoing from my office, our two male Shetland Sheepdogs, Alex and Lance, came running into the room, barking with agitation. After they had looked around and determined that nothing terrible was happening, they lay down on the floor and listened attentively to the sound of the Big Bang, giving their characteristic Sheltie Stare to my sub-woofer.

My *Mathematica* program (or "notebook" in *Mathematica*-speak) combines the frequencies measured by WMAP and adds up the cosine waves correspond-

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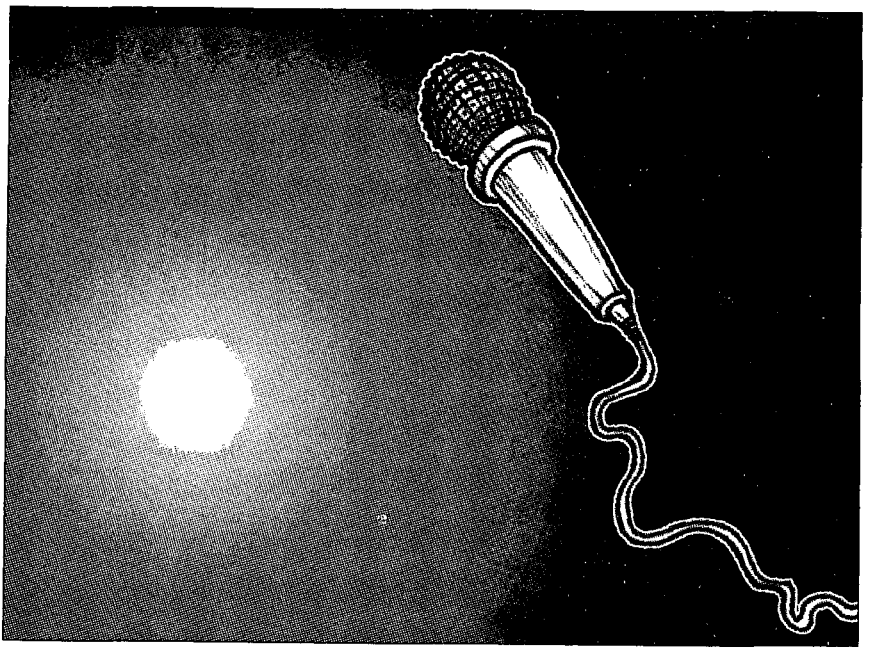

Illustration by Wolf Read

ing to all of the data points, with each wave given an intensity that corresponds to the area it would represent on a bar graph. (This is done so that closely-spaced data points are not over-weighted as compared to widely spaced points.) The actual Big Bang frequencies, which had wavelengths that were some fraction of the size of the universe at that time, were far too low in frequency to be audible to humans (even had any been around). Therefore the WMAP frequencies had to be boosted upward by a huge factor (about 10^{26}). The waves of all frequencies were set to start at their maximum values at t=0, which in the simulation corresponds to the start of the Big Bang.

The simulation includes three important effects: (1) The multiply peaked frequency spectrum measured by WMAP is made into a single sound wave (monaural, not stereo) by the process described above; (2) According to the WMAP analysis, the emission profile of the cosmic background radiation peaked at 379,000 years and dropped to 60% intensity at 110,000 years before and after the peak emission time. The simulation lasts 100 seconds and represents the first 760,000 years of evolution of the universe, as the emitted CBR rises and falls in intensity following the WMAP profile; (3) The universe was expanding and becoming more of a "bass instrument" while the cosmic background radiation was being emitted. To put it another way, the expanding universe "stretches" the sound wavelengths and thereby lowers their frequencies. To account for this effect, the program shifts the waves downward in frequency to follow the expansion in the first 760 thousand years of the universe. How fast the universe initially expanded depends on what cosmological model is used. I decided to follow the predictions of the flat-space Robertson-Walker metric with zero cosmological constant. That model predicts that the radius of the universe

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grows as time to the 2/3 power ($R \sim t^{2/3}$). Therefore, instead of the component cosine waves varying as *frequency x time*, they vary as *frequency x time*$^{1/3}$ to implement the cosmological Doppler shift. The resulting *.wav* file, along with several variants of it with other running times, can be downloaded from my web site at http://faculty.washington.edu/jcramer/BBSound.html.

After I had produced the *.wav* file, I sent a copy as an E-mail attachment to Daniel. His mother reports that his science project was a great success. I also mentioned the simulation to Marcus Chown, a science writer with whom I frequently interact and who writes for *New Scientist*. Marcus wrote a short article about it, and it was publicized in a *New Scientist* press release about their upcoming issue. The result was an amazing media explosion. The story was picked up by newspapers and news services around the world, including *Aljazeera*, the *Telegraph* (UK), *Ananova* (UK), news.com.au (Australia), *The National Post* (Canada), *EurekaAlert!*, *The Mirror* (UK), *The Australian*, *The Brisbane Courier Mail* (Australia), and *The Frankfurter Allgemeine* (Germany). It was also the feature front page story in the Turkish newspaper *Sabah*, crowding out reports of the October California fires. I was interviewed by three different parts of the BBC in the same 24-hour period, and I did several other radio interviews including a "Living on Earth" segment for National Public Radio. Many thousands of file requests for the *.wav* file hit our local web server, which was making the audio file available, and filled its hard disk, causing an ugly system crash. We had to move the file to a more robust system to deal with the traffic. Things have calmed down by now, but our server still gets many download requests.

Apparently the sound file is also of interest to musicians. I was interviewed by a news service that focuses on music. The sound file in several running lengths was placed on a server that provides sound files to radio stations and the music industry.

Frankly, I'm amazed by the vibrant chord of public response that was struck by this little exercise in data presentation. My hour of work on a quiet Saturday morning has generated more interest in my work than all the rest of my scientific output in a long and varied career of scientific research and popular science writing. I'm now wondering what I might do for an encore. The Sound of the Galaxy? The Sound of the Sun? The Sound of a RHIC (Relativistic Heavy Ion Collider) Collision? Suggestions (in moderation) would be appreciated.

Finally, here are the answers to two recurring questions that have been asked about the sound file:

Q: How can you represent it as a sound? Sound is supposed to be a wave that travels through air, and there was no air in the early stages of the Big Bang?

A: The Big Bang Sound in the simulation is derived from the sound propagating as compression waves through the plasma/hydrogen medium of the early universe some 100 to 700 thousand years after the initial Big Bang. The density of this medium was changing as the universe expanded, but should have been considerably more dense than air on our little planet. One does NOT need air to have sound, only some medium in which compression/rarefaction waves can propagate. The sound waves were very low in frequency and had wavelengths comparable to some fraction of the size of the universe. For the convenience of humans, who could not hear such low frequencies, I have increased them to the audio range of the human ear.

Q: How could the universe have a radius of 18 million light years only 0.76 million years after the Big Bang. It would have to be expanding faster than the

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speed of light.

A: The VISIBLE radius of the universe at age 760,000 years is, of course, 760,000 light-years. However, even at this early age the scale radius of the universe is already larger than its visible radius, with regions already out of causal contact. The SCALE radius of 18 million light years mentioned in the *New Scientist* article is an estimate based on assuming that the universe expands as time to the 2/3 power (as it would for a flat Robertson-Walker metric with zero cosmological constant) and propagating backwards 3/2 of the present visible radius of the universe to its scale radius at age 760,000 years. ■

AV Columns Online: Electronic reprints of over 120 "The Alternate View" columns by John G. Cramer, previously published in *Analog*, are available on-line at: http://www.npl.washington.edu/av. Electronic preprints of papers listed below are available at: http://arxiv.org.

Reference:

WMAP Data

"First Year Wilkinson Anisotropy Probe (WMAP) Observations: Preliminary Maps and Basic Results", C. L. Bennett, et al, submitted to Astrophysics Journal, preprint astro-ph/0302207 available at http://arxiv.org.

The secret of being miserable is to have the leisure to bother about whether you are happy or not.

—George Bernard Shaw

It is easier to fight for one's principles than to live up to them.

—Alfred Adler

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Damned If You Don't

Jerry Oltion

You can't do just one thing—which forces decisions that technology alone can't make.

"I'm afraid I have some bad news," said Dr. Turner. He leaned against the edge of the cabinet in the corner of the exam room, his arms crossed over the unbuttoned front of his white lab coat, his right hand toying with his beard.

David Maddox sat upright on the crinkly paper that covered the padded table. His bare chest was stippled with goosebumps. The bumps grew more prominent as the doctor's words sank in.

"What kind of bad news?" he asked.

Dr. Turner said, "The antidepressant you've been taking has been determined to be carcinogenic."

"Oh," said David. He took a deep breath. Not as bad as he'd feared there for a second. It wasn't like he *had* cancer—his first fear whenever a doctor said he had bad news.

Or did he? "How carcinogenic?"

"That's a good question. Unfortunately, we don't know the answer except roughly. Preliminary tests show that it's about twice as dangerous as smoking."

"Which means?"

"Which means if you keep taking the drug, you will almost undoubtedly get cancer, if you don't die of something else first. But it could be anywhere from five years to a hundred years down the line."

"Oh," David said again. "So what else can I take for depression?" The idea of going off medication wasn't even a consideration; the year and a half since he'd started was the best year and a half of his life, with the exception of the three months when he'd tried to go off it to see if he could keep his newfound happiness without assistance. He'd even begun patching up his social life, though at thirty-five he was discovering that all the single women were either far younger or even more screwed up than he was.

Dr. Turner tugged at his beard. It was such a stereotypical gesture that it made David grin. In his former state, he would

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never have noticed.

"Well, that's the problem," the doctor said. "All the modern antidepressants work on essentially the same principle, and it turns out they've all got the same problem. We could try Valium or lithium, but they're pretty crude and they have pretty dramatic side effects."

"I'd say cancer is a pretty dramatic side effect. Why didn't they catch this before the drugs went on the market?"

Dr. Turner shrugged. "Giving high doses of test compounds to lab rats has always been a suspect method of determining risk. Some things don't scale up the way you expect them to. The long-term effect of antidepressants was buried in the data."

"But now you know the risk. So what do you want me to do?"

"What do *you* want to do?"

Doctors nowadays always did that, turned a perfectly good plea for an authoritative decision into a new-age quest for inner truth or something. What David *wanted* to do was keep taking his current medication without having to worry about cancer when he was fifty. That apparently wasn't an option.

"What choice do I have? The FDA is bound to pull all these drugs off the market, isn't it?"

"We've managed to keep them at bay for now," the doctor replied. "Fortunately—or perhaps not, depending on your point of view—all but two of the members on the review board are currently being treated for depression. They don't want to go back to the way they were any more than you do."

David supposed running the FDA could be a pretty stressful job. He'd never thought of people in that position suffering the same inner doubts as he did. Like most people, he thought of government employees as faceless drones to curse when things didn't work right. Now that he momentarily considered their humanity, it didn't cheer him to realize they shared his curse.

"So I can be happy and probably die an early death from cancer, or I can be depressed and live however long I can stand it until I throw myself in front of a bus."

"If that's actually your choice, then I'd think it's fairly easy to make," said Dr. Turner. "But from what you've told me, I don't think you were ever actually suicidal, were you?"

"No, just grumpy." David shifted his weight, and the paper beneath him rattled. "Well, angry, really. Mood swings. Irrational outbursts. I don't want to go back to that."

"Take some time," Dr. Turner said. "Think it over. Keep taking your pills for now. You're not in any immediate danger."

Then why did David feel like a horde of tiny ants were crawling around inside him, eating away at his body already? But he said nothing, only pulled on his shirt and left the doctor's office with the pink receipt for his insurance deductible fluttering in his hand.

He stood beside his car in the parking lot, listening to the birds in the cherry tree between the lot and the street. It had been raining when he arrived, but now the clouds were breaking up. David tucked his keys back in his pocket along with the receipt and walked over to the tree. The birds flew away with a rustle of wings, but David stopped and looked at the buds swelling on the branches. Spring was coming. The sun would soon be out more often, and Seasonal Affective Disorder would be less of a factor. He could maybe go off the antidepressant at least through the summer months, and go back on it through the winter. That hadn't worked last summer, but he'd had, what, eight more months of happiness to build up good habits. Maybe that would make a difference.

Maybe, maybe, maybe. He turned away from the parking lot and walked down the street. The hospital loomed up on his left; he walked past it, then turned left on the next block and walked toward the university. Panhan-

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dlers and street people—most of them younger than himself—yammered at him along the whole length of the final block before campus, some of them entreating, some of them offensive, but he ignored them all, lost in his own concerns.

All but one. He'd seen this woman before, across town at the post office, begging for money for a hot meal. She was maybe thirty, still younger than him, but not by as much. He remembered her strawberry blonde hair, her freckles, her earnest expression. He'd given her a dollar, wondering as he did so if she was really in need or not. Her hair had been clean, her clothing worn but not ragged. She'd had an umbrella. He had found himself momentarily attracted to her, until she'd asked him for money.

Now she looked even better. She was wearing a tight purple sweater and had a white flower in her hair. She smiled at him with even, white teeth. "Spare some change?"

He had no change to spare, save a few pennies. He'd just opened his wallet to pay his deductible at the doctor's office, and he knew there was only a five and a twenty in it. He shook his head, saw her smile fade, and that little motion made him stop.

"Just something for a hot meal," she said helpfully.

"Tell you what," he said, hardly knowing before the words came out what they would be, "I'll give you five bucks for some advice."

She snorted. "Sure. Get a life. That's what people keep telling me."

The college kids laughed. So did David. He took his wallet from his back pocket, extracted the five, and handed it to her. "That's not the kind of advice I want."

"What, then?"

She tucked the five away between her breasts. One of the college kids beside her said, "Ooh, Abe's happy now!"

"Walk with me," David said. He didn't want to talk in front of these dropouts. He wasn't sure he really wanted to talk to her, either, but he waited while she looked at him appraisingly. Her choice.

"I don't do that sort of thing," she said after a moment.

That wasn't what he'd expected her to say, but now that he thought about it, it was a perfectly natural assumption on her part. "What, walk?" he said, keeping the innocent face. "It'll do you good."

The kid laughed again. "He's got you there, mama. You need to work off some of that fat ass from all those *hot meals*."

"Bite me," she spat at him. Like a cobra striking, David thought, but when she turned back to him she was all smiles again. "All right, let's walk." She turned away and stepped into the street without looking, forcing a Volkswagen to screech to a halt to avoid hitting her. David leaped after her but she kept walking as if nothing had happened, and he fell in beside her.

"You should look out before you walk into a street like that."

"I thought you were the one who wanted advice," she said. They went under the canopy of trees at the edge of campus and started down one of the long, straight sidewalks that split the acres of grass into geometric shapes.

"Consider that a tip," he told her.

"Thanks. But I get hit by a car, I make a lot of money. Better odds than a lottery. So what do you want to know?" she asked.

"You mean that?"

She looked over at him for the first time since they'd begun walking. There was no hint of humor in her face. She was either a good actress, or she meant it. "What do you think?"

"I think you already answered my other question," he said. They walked a little while farther, then he asked, "How much do you make in a day, anyway?"

"What is this, twenty questions? You paid for advice. So ask me for advice." She shoved the five dollar bill deeper into her cleavage with an index finger.

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David watched, admiring the roundness and softness of her breasts. How far down did those freckles go, anyway? He realized she was watching him watch her, and he looked away, embarrassed.

And now he felt embarrassed to ask a street person about such a yuppie situation, but he couldn't think up a convincing alternative. "All right," he said, "Here it is. I've got chronic depression. The medicine to keep me happy actually works, but it turns out it's deadly. Carcinogenic, but they don't know how bad. So do I take it or not?"

She didn't say anything for a dozen steps.

"Well?"

"I'm thinking."

He let her think.

After they'd passed the statue of the pioneer father, about a block or so in from the street, she said, "You think I already answered that, do you? So what did I say?"

"You'd do it. If you could afford the drugs. It's a hell of a lot less dangerous than stepping out in front of a car."

She laughed. He liked the sound of it; it wasn't derisive, just amused. After a moment she said, "I make a hundred bucks a day, average. Some days, when I decide to look really pathetic, I make twice that. I could afford your drugs."

"A hundred bucks a day?" David asked, shocked. "You're kidding."

"If you say so."

"I—wow. I would never have guessed that much."

"Well, don't let on. The more people do it, the less I get. There's only so much generosity to go around in this town."

They reached the student union, turned right past the alumni dining hall.

"What did you do before you . . ."

"Became a vagrant? Jeez, what didn't I do? Cleaned houses, waited tables, danced topless—" She wiggled her breasts. Paper rustled softly inside her sweater. She laughed when David blushed again. "That pays even better than begging, but I got tired of all the fat slobs staring at me. Don't those guys have anything better to do?"

"Probably not," David said, trying to imagine her on stage under colored lights with only a g-string on.

"That can be taken two ways," she said.

"Yep."

"You're all the same."

He shrugged, but she had looked away. She kept walking beside him, though, past the tennis courts and even turning into the cemetery rather than heading farther south alongside the athletic stadium.

"Are you happy, then?" he asked as they swished through the fallen needles in an avenue of enormous incense cedars.

"Define happy."

He laughed. "If I could define it, I could probably *be* it without drugs."

"So take a stab at it."

"Right. Okay, then, not sad. Not hungry, not—"

"That's what it isn't. What *is* it?"

"Did you practice psychology after you quit dancing?"

"Before. That paid better yet, but the customers were even more pathetic." She laughed again.

For a minute or so David considered saying, "Happiness is hearing you laugh like that," but he was afraid of what it would do to the fragile bond they'd already built. He got the feeling that a single comment like that from him would send her running like a scared rabbit.

Why did he care, anyway? She wasn't his type. She was pretty and intelligent, but an ex-stripper, a beggar?

Well, why not? He hadn't had much luck with the accountant or the bank teller or the radio disk jockey, had he? He had a momentary fantasy of taking this woman home, giving her a room of her own in his echoing cavern of a house, letting her get her feet under herself again, the two of them falling in love and living happily ever after.

But what was "happy"?

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"Warm," he said. "Comfortable. Good books. Good music. Quiet time to enjoy it in."

"That's better, but I didn't hear anything that you need drugs in order to have. What did you leave off the list?"

"Peace of mind," he said, and he knew this time he'd hit it.

So did she. "Aha," she said. "They sell that for $5.95 a quart at Safeway."

"What, Ripple? MD 20-20?"

She giggled. "I was joking. But yeah, now that you mention it, some people find peace of mind in a bottle. It eats up their liver, though. Probably more dangerous in the long run than the stuff you're taking."

"But people still drink, knowing what it's doing to them," David said. They reached the other end of the cemetery and angled around the library back toward the street where they had met.

"They're addicted. You're not. At least I assume you aren't. But yeah, they know."

"Makes me think my problem isn't all that monumental after all," said David. "All I have to worry about is some hypothetical risk maybe a decade or two down the line."

She looked over at him with the most serious expression he'd seen on her face since she'd asked him for money. "Tell me that when you're taking chemotherapy to kill your cancer."

David shivered. Damn, but she was good at manipulating people. She had quashed his growing conviction with a single sentence.

They crossed the street—he looked both ways before he would let her step out—and walked back to the corner where they had started. The kids who had been with her before were halfway down the block, arguing with an old man.

The woman reached into her sweater, pulled out the five dollar bill, and stuck it back in David's hand before he could resist. He felt its warmth against his palm.

"What's this for?" he said. "You earned it."

"No I didn't. You paid me for advice, not a walk."

"I got my money's worth."

She shook her head. "I never answered your question."

"Yes you did."

"Oh? Then what are you going to do?"

David stammered. "Wha—that? I don't know. But that wasn't the question. I wanted to know what you'd do."

"And you think you know that?"

"Sure I do. You'd take the medicine. I mean, well, wouldn't you?"

She shrugged. "I don't know." She looked up the street, then back at David. "Fortunately, I don't have to know. Whatever troubles I've got, depression's not one of 'em. But you've got one hell of a problem, honey. Come back and tell me what you've decided, if you ever do."

If you ever do. Her words still echoed in his mind weeks later. He was still taking the pills, but each night as he felt the hard lump slide down his throat he imagined the chemicals invading his cells, altering the genetic machinery, just a little here and a little there, until some day one of them would trigger the wrong strand of DNA and all the interest on his happiness would come due at once.

If happiness was peace of mind, then he had already lost it. But he knew the depth of despair that awaited him if he stopped taking the pills, and mere anxiety was nothing compared to that.

So what was he supposed to do? Just mark time until the inevitable? He wanted an answer, damn it!

At one point, on a sunny Saturday afternoon, he found himself stalking through his house, fists clenched, looking into every room as if the answer might be lurking there like a frightened cat under the bed. When he got to the dining room he gripped the edge of the table and nearly tipped it over just to

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hear the crash, but he stopped. Breaking furniture was no solution. He'd already learned that.

He sat down in a chair and leaned his elbow on the table. Maybe there was no solution. No permanent one, at least. Maybe happiness wasn't something you could pin down, even if you could put it in a bottle.

Maybe, maybe, maybe. Maybe he was looking for the wrong thing. He was still taking the pills; that was probably answer enough to his question. So what was he looking for now?

He looked at the house around him, full of furniture and pictures on the walls, but still empty. A little piece of the American Dream, but it wasn't the whole picture, was it? He wasn't *happy;* all he was at the moment was not depressed. Even now, he wasn't as depressed as he would be without medication.

That's what it isn't, the beggar woman had said. *What* is *it?*

Okay, if he looked at it that way, then he wasn't looking for an answer so much as validation for the decision he'd already made. He'd banished the worst of his demons; now it was time to do something to make the time worthwhile even if he died of cancer in five years.

Yeah. "Get a life." That was the first thing she had said to him when he'd asked her for advice. Was she some mystical fortune teller, some kind of Earth spirit who dropped into his path just to nudge him in the right direction?

Hardly. He'd seen her at the post office again just a few days ago, looking rattier than he'd ever seen her before and raking in money by the handful. He'd considered asking her out for a hot meal, but he'd lost his nerve before he'd even gotten out of his car. He knew nothing about her, really.

But he realized now that he wanted to learn. She might not be the answer to his dreams any more than anyone else had been—the odds of her being so were astronomically bad, considering their different lifestyles—but that very difference might provide something to live for, at least for a little while. Some reason to get up in the morning, whether or not he took his two-edged pills at night.

He got up from the table and took his car keys from their hook by the door. On his way out he checked his wallet to make sure he had a five dollar bill to pay her for the advice that had, after all, turned out to be worth every penny. ■

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Honor Is Golden

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Suzette Haden Elgin

Illustration by John Allemand

A key part of wisdom
is learning to live with ignorance.

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It was truly beautiful to look at; as miserable as she was, as much as she hated the sight of it, Oka was willing to admit that. As far as she could see in every direction, the towering buildings of Golden glowed at her. "Every direction" meant more on Golden than it did on Earth, because all of the buildings were completely transparent—walls, floors, ceilings, beams, hardware, every least part. If any structures on this planet provided even a scrap of privacy, they were well hidden and secret; so far as she knew, nothing of the kind existed here. From where she stood waiting for her husband, she could see straight down through the sixty-six floors of the building below her, straight up through the nine floors above her, straight out through the walls all around her. When darkness fell the view was splendid, and magnificent. And terrifying. And it went on forever.

Most people—most human people—had been sure that the concept of a single planet-wide city was nonsense, the stuff of amateurish science fiction; Golden had proved that false. Except where a body of water or some obstacle like a large canyon or mountain made it impossible (and the rare plastiglass-enclosed open spaces, that were like parks but were only for looking at), the single city with its unpronounceable name covered Golden completely. That made it possible to identify it simply as The City, and never mind its name.

"You'll get used to the view," her superiors in Washington had told her. "After a week or two you won't even notice it." They were wrong; she had been terrified by it when she and Uri arrived on Golden seven months ago, and she was terrified by it now. She did try to put it out of her mind, and she'd gotten a little better at doing that, but she was still terrified. When she looked down, her perception was not that the structure stretching endlessly away beneath her was bearing her up. Her perception was that she—and all the many others she could see sitting and sleeping and going about the business of their lives—were floating without anchor in an enormous spangled emptiness. Uri thought she ought to be able to *enjoy* that. "I envy you that perception," he had told her when she complained. "I just wish you had some way to share it with me!"

Because her eyes were closed to keep out the view, she didn't see Uri coming up through the building and through the door, and she flinched, startled, when he touched her arm.

"I'm late," he said, as she opened her eyes. "I'm sorry, love."

"Well, of course you're late," she said gently. "I expected you to be later than this. How bad *was* it?"

Uri looked down at the floor.

"How bad?" she said again.

He looked at her, his face thin and drawn, smudges of darkness under his eyes, a muscle twitching high in his right cheek, and she looked steadfastly back, knowing she was just as pitiful a spectacle as he was.

Two sorry linguists, she thought. *In both senses of the word.*

"It was bad, Oka," he said slowly, his voice harsh with weariness. "But no worse than usual. When can they expect some useful information? How could we possibly spend seven months doing linguistic fieldwork here and still have nothing useful to give them? Where is the preliminary dictionary? How could we possibly not have put together even the Core Vocabulary List yet, after all this time? Don't we know that the future of the almighty United States Corps Of Linguists rests in our hands? Don't we know that the honor of the human race is in the balance here? Don't we know that all of USCOL and all of humankind are depending on us? And so on, and so on, and so on."

"*Don't* we even *care*?" she said through clenched teeth. "Have we no *shame*?"

"Exactly."

Their minders—two female Goldies

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for her, two males for him—were kneeling on the bare floor in a corner of the room, pretending to be absorbed in conversation but really watching with their customary vigilance. Oka had developed no tolerance for the view, but she was used to the minders now. Suppose that she was at any moment going to go plunging down through all those floors beneath her, as her brain kept insisting; then perhaps her minders would catch her. They were very tall and very supple, and they had three arms; they should be good at catching things.

The minders hovered over the linguists like nannies, day and night; why they did that, she had no idea. Maybe Terrans triggered some innate protective instinct in them, like the way baby seals affected human beings? Possible. Maybe the Goldies had figured out how much it cost to keep a member of USCOL at a fieldwork site and were unwilling to risk the loss of anything so expensive? Possible. Maybe the Goldies were tending them carefully because they planned to eat them one of these days? Oka didn't think so, but she didn't have enough information about the culture to make her certain. Who knew? Who knew what went on in the heads of a people who lacked even the *idea* of privacy, for just one example? That was truly alien, far more alien than the three arms, and it wasn't something she and Uri had been able to adapt to. On all of Golden, only she and Uri went around with a soundproof folding privacy tent—complete with detachable floor—on their backs, ready to be set up fast, at a moment's notice.

She had no idea whether the minders knew that their charges' physical appearance should tell them that something was very wrong, just as she knew nothing at all about how a healthy and happy Goldie ought to look. The minders looked perfectly comfortable to her, sitting on the hard bare surface of the floor; they never bothered to reach for any of the pillows or sitting-mats that were always scattered around. Perhaps the way they looked to her was an error of perception on her part; perhaps the way they ignored the pillows and mats meant *they* were overstressed and ill.

If she could have talked to them, she could have asked them about some of these things. But she couldn't say even hello or goodbye and be *positive* that that was what she was saying; she couldn't even say their names. She and Uri had nothing from the Golden language that she could be sure of except an assortment of sounds. And not the complete array of sounds that would have let them at least send back a rough analysis to USCOL headquarters; only the ones that were close enough to the sounds of human languages.

It had all seemed so straightforward in the beginning. The Goldies had arrived almost decorously, sending a message in Panglish months in advance so that there would be no surprise, giving the people of Earth time to get used to the idea of visiting aliens. Two of the party (presumably the Golden equivalent of professional linguists) had arrived speaking a modest amount of Panglish; they had been able to learn the human language that served as a WorldSpeak on Terra, just from their surveillance of the planet. All ten of the party had arrived knowing the 100 essential items of Siglish.

How long had that surveillance been going on, and how had it been done? If you were a human being, the question brought with it a funny feeling between your shoulder blades. The Goldies had been pleasant but vague. They had been observing Earth's communications "a while." They had used "some computers." The Goldies had been able to do that, somehow. It should follow, therefore, that a fieldwork team of human linguists would be able to learn the language that served as *their* lingua franca or—if they had nothing like an international language—whatever Golden lan-

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guage was most widely used and was therefore most appropriate for interplanetary diplomacy and trade.

It was nothing like the situation with the first two extraterrestrial communication systems that humankind had encountered as they explored the universe. One of those ETs had been a creature that looked like a four-foot-tall praying mantis; the other had been a sentient blue fungus. It surprised no one that USCOL hadn't been able to learn those two languages. (If they really *were* languages; the behavior that looked like communication to Terrans might well have been something else.) No one expected USCOL to learn the native tongues of bugs and fungi; the linguists who believed no human would ever be able to learn a nonhumanoid language had written a dozen articles explaining that it was impossible, and why.

The Goldies were a different matter. They were unmistakably ET, but they were also unmistakably humanoid. True, they had three arms, two on the right side and one on the left; their bodies and faces were covered with short white fur; they were taller than most human beings, and supple with an inhuman suppleness. But their features were like human features, their smile was like a human smile, their hands and feet (the palms and soles bare of fur) were like human hands and feet.

The Goldies were a different matter altogether.

By the end of the third month, as she and Uri worked harder and harder and continued to make no progress, Oka had started having nightmares about what was going to happen. She dreamed that she was sitting in a hearing room in Washington, facing the battery of senators. All of them peering down at her where she sat alone at a small table, shouting at her in unison like a choir. "Do you mean to tell us that these aliens are intelligent enough to learn a *human* language, but we human beings are too stupid and too primitive to learn one of *theirs*? Is that the shame we are going to have to live with? *Is that what you are telling us, young woman?*" She was opening her mouth to say yes, she regretted it deeply but that *was* what she was telling them, but before she could make a sound she would be wide awake, sitting bolt upright in panic in the bed, drenched with sweat.

And then there was the nightmare that was even worse, the one where she had to face Uri's parents. They were linguists, too, both of them. Famous linguists. Distinguished linguists. Uri had followed in their footsteps and he was their beloved only son—who could do no wrong, but had somehow been tricked by Oka into an unsuitable and unworthy marriage.

She realized that Uri and the four minders were staring at her, and she smiled the skillful reassuring smile that every USCOL linguist was trained to produce on demand. "I'm so sorry," she said, and she meant it in spite of the artificial smile, because the last thing Uri needed right now was a wife whose mind was wandering. "It's been a long day—I'm afraid I was almost asleep."

One of the minders smiled back at her and leaned forward, forming the Siglish shapes that meant EAT and then QUESTION; because they had three arms, Siglish was easier for Goldies than it was for Terrans. Oka made the YES shape and Uri followed her lead, and the minder's fingers flew to the computer around her neck, sending the order that would bring their dinner to the food portal in the wall. For Oka and Uri that meant two packets from the year's supply of USCOL rations they had brought with them; for the minders, it meant four steaming platters of unknown substances that looked something like a grain and something like vegetables. There would be a supply of things to drink; bottled Terran water and Terran wine, bottled Golden liquids as mysterious as the foods. All moving up through

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the building to the room's food portal in transparent containers that kept them in order for the trip.

Oka remembered the first time she had tried to find out the name of one of the vegetables, on their second night on the planet. Wearable computers had made linguistic fieldwork easier; you didn't have to take notes any more, you could just go on with whatever you were doing and rely on the computer to make a flawless record of the stream of speech and the body language that went with it. She had done the Siglish shapes for WHAT and QUESTION and pointed at the small round red thing on the minder's plate.

"Ard," the minder had said.

"Ard?" she said back. Checking.

Siglish YES. And "Arl."

"Arl?" Checking again.

Siglish YES from the minder. And "Ar-*sound-of-crockery-breaking.*"

Oka had been sure that she'd gone astray somewhere, and that pursuing the matter would be rude. She had smiled and Siglished THANKS and let it go. And the next day she had gone to her comset and contacted one of the two Goldies who spoke Panglish. (*Why were there still only two? Why weren't lots and lots of Goldies taking Panglish classes? Did they think Panglish was too primitive to be worth their time? Did learning a language violate a religious taboo, so that it could happen only when religious dispensation had been given? Were most Goldies just not able to learn anything so sophisticated and complex, with the two they'd sent to Earth being the rare exceptions?*) "I'm having trouble with a word," she had said. She described the little vegetable, and asked for its native name.

"Arb."

"Arb?"

"Yes. Ark."

"Could you say it just once more?"

"Of course. Ar-*sound-of-cat-meowing.*"

There was something a little bit like this in linguistic fieldwork on Earth. A word would be sometimes "ta" and sometimes "da"; you'd hear "ta" and say "ta?", checking, and get back "Yes; da." It meant that the two very similar sounds T and D were only one sound in that language, and a linguist could deal with that easily enough. But there was no situation with a human language in which a sound was sometimes D, sometimes L, and sometimes the sound of crockery breaking or a cat meowing. There was no situation in which, as happened with the Golden language, it was possible for the two linguists who were listening to hear the sound entirely differently—B for one of them, sound-of-cat-meowing for the other. It did not and could not happen. Spoken language was patterned sound, and the human brain scanned for it and sorted it tidily out. But what if there *was* no pattern?

"It has to be a language," Uri insisted, to her and to their superiors in Washington. "We see them communicating with it. We see it constantly—it's not ambiguous. The ones who know some Panglish *say* it is a language."

"Do you suppose they could be lying to us?" Oka had asked him once.

Uri had stared at her. "No," he said, almost angrily. "Of course not. Only *you* would suggest something like that!" But then he had reached out to touch her cheek, smiling at her. "Which is, of course, the reason they sent you with me."

"Not for my formidable mathematical and theoretical skills, you don't think?"

"No, love. Not for either of those."

It was true. Uri had the mathematical and theoretical skills. Oka's strength was her ability to get from A to Z by paths that other linguists would have rejected because they were so impossible to explain and so lacking in rigor. And yet those unorthodox paths usually took Oka where she needed to go.

Usually. Not this time. This time, Uri's parents had been right. They had plead-

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ed with USCOL to send another theoretician with Uri and Oka, "just to provide balance—because this is so terribly important." They had done that pleading right in front of Oka, without the slightest hesitation. Which was rational and correct; Oka's feelings mattered not at all in a case like this, when the honor of humankind was at stake.

USCOL's refusal to put a third linguist on the team wasn't because they were worried about Oka's feelings. They were worried about *money*. "Every year they cut our budget again," their chief had said. "After all, what we do is only talk, right? How important can it be? Getting the money to send a team of *two* took the kind of horsetrading you don't want to know goes on here in Washington; sending three is absolutely impossible."

"Then send Uri and another theoretical linguist," her mother-in-law had said instantly.

"No. We're sending Oka with him. They're the best team we have; they work superbly well together. They've cracked languages that nobody else could even *begin* to analyze. They'll come through for us."

They'll come through for us. It hurt just to think the words. They hadn't come through, and when they were ordered back to Earth it wouldn't be just Oka who would be in disgrace, a circumstance as familiar to her as her shoes; it would be Uri as well. He had followed the family tradition and become a linguist, he had always done them proud before, and now—because of Oka—he would be in disgrace. That's how they would see it. They would never forgive her. And perhaps Uri would never forgive her. There had never been a disgraced linguist in his family before, and the tradition went back four generations.

It has to be a language, therefore there has to be a pattern; and I have to find it. Those three propositions were clear to Oka; they were with her always, like the beating of her heart.

But it wasn't the disgrace, or her in-laws' undeviating hatred, or the threat to her marriage, that really mattered. She knew that. She knew what Uri would say. "How can you think about what this means just for *you*? We can't learn the Goldies's language, even with months of work by what USCOL claims is their best team of linguists. But *they learned one of ours*—or as much of it as they thought was worth the effort—and they didn't even need fieldwork. All they had to do was listen to us on their comsets, or whatever gadget they used. How is humanity going to live with that, Oka?"

There has to be a pattern—and I have to find it.

Sometimes Oka found herself wishing that the surface beneath her *would* open up and let her drop through it, past all the shocked and staring Goldies on the floors below, to her death. She wasn't proud of that wish, but there were times when she was aware of it in her mind, and there were times when it tugged at her. What was ahead of her was going to be so hard to bear; how was she going to do it? How was she going to find the strength?

The night before she and Uri were to return to Earth to face what waited for them there, Oka was simply numb. She knew that she should have been going over their notes one more time, and then as many more times as she could squeeze in before they were picked up in the morning . . . trying desperately to find something, anything, that they had overlooked and that might be a clue. That was how Uri was going to spend this last night. But Oka had no hope left, and no will left; she was so ashamed and so heartsick that she could no longer put two coherent thoughts together.

I give up, she thought. *When there's nothing more to do, why keep doing all the things that have already been proved useless? It would make a lot more sense to play my guitar.*

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This was only posturing, of course, only self-comforting self-talk. It wasn't that she had a rational argument for her choice. She had given up, and she was too distraught to sleep, and she despised herself, and so she would play her guitar.

She sat down on the floor beside a window; she took the little guitar from its case and tuned it; she played a children's song; she mourned. She opened a folder of music she hadn't played before, thinking that something different might distract her from her misery and her shame, and laid the music sheet on the windowsill where she could see it easily. It was convenient, she thought, that the Goldies had also seen the usefulness of windowsills.

"Space Carnival," the piece was called. Trite. And it looked hard to play. 5/6 time . . . who would write in 5/6 time? And look at all the rests! She scowled at the page, speckled and ugly with the rest symbols. Why? Why would anybody write something all full of rests like that?

Full of rests.

She stared at the page, frozen, forgetting to breathe.

Full of rests!

Oko leaped from A to Z.

She dropped the guitar and didn't stop to find out if she had broken it, she just ran for Uri. And when he turned on her, telling her that he had to work, pleading with her not to interrupt him when time was so precious, she reached over and put both hands over his mouth.

"Hush!" she said sharply. "You hush!"

His eyes widened, and she took her hands away.

"I'm sorry," she said. "Uri, I mean *please* hush. Please listen to me. Uri, I think I know what to do!"

Explaining to the senators turned out to be easier than explaining to Uri's parents; at least the senators didn't keep interrupting her and saying horrible vicious things. ("It didn't cross your mind, Oka," her mother-in-law had said, "that it would be more appropriate to say that Uri had solved the problem?"

"Or at *least*," Uri's father had said, "to say that the two of you had solved it together?" They would never forgive her. If she was very lucky, Uri—who kept saying he didn't mind, kept telling her that scientific accuracy was what mattered and that she had done the right thing—would be able to forgive her.) The senators, by contrast, had listened almost respectfully.

"The problem," she told them, careful not to use jargon, "is that all human spoken languages are made up of vowels and consonants. There isn't anything else. You can do lots of things *to* a vowel or a consonant, but they're all you have to work with. The Golden language we were sent to analyze—we call it Moth because there's a chunk in the name that sounds like 'moth'—that Golden language has vowels and consonants too. But it also has something else, something that isn't part of human language but plays the same role in Moth that vowels and consonants do in English or Cherokee or Chinese. When the human brain hears one of those segments it tries desperately to make sense of it, but it can't, and so a linguist keeps hearing it as something different."

The senator closest to her frowned, and rubbed at his forehead with the palm of his hand.

"I don't get it, Professor," he said, sounding cross. "All those sounds you're talking about—dishes breaking, cats meowing, and so on—we have those sounds on Earth, right? But we know they're just noises. How come it doesn't work that way in—what did you call it? Oh, yeah—in Moth. How come it doesn't work that way in Moth? How could it *not* work that way? I can't imagine such a thing!"

"That's exactly the point," Oka said. "Human beings are hard-wired for human languages. We're designed neuro-

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logically to recognize only certain things and combinations of things as languages, and we're not able to imagine anything else qualifying. We have a whole universe of sounds around us, just as you say. The first thing we do, faced with all that data, is divide sounds into language and non-language. The next thing we do is divide the sounds that are language into vowels and consonants, and we can't imagine there being something *else* that would be part of language. For the Goldens there is something else—something alien, something we can't even imagine—that's part of language in the same way that vowels and consonants are. There may be only one of those alien language-parts or there may be more than one; we have no way of knowing. They may be stable units of sound, the way our own phonemes—our own meaningful sounds—are stable, or they may not; we have no way of knowing that, either. Whatever they are, our brains are able to make the right division between language and nonlanguage—presumably the reason we can do that much is because Moth is humanoid—but that's as far as we can go. Faced with all the sounds that are language on Golden, we can identify the vowels and the consonants, but we're hopelessly lost with the others. Our brains keep trying, but they can't do it, they just flounder around. Fortunately, I finally realized that that didn't matter."

A senator leaned forward and opened his mouth to speak, but Oka raised her hand to stop him.

"Hang on just one minute, please, Senator," she said. "I'm almost finished. The language is complicated, certainly, but the solution for dealing with it is really very simple. You know how in music, when part of the melody is a silence of a certain size and shape, you use a symbol called a 'rest' to write that down? I was looking at a piece of music all full of rests, and I suddenly realized that we could handle the sequences of Moth that way. The other parts of the words are unquestionably stable, it's only those non-vowel/non-consonant segments that human beings perceive as sometimes one thing, sometimes another. So I had the computer replace every last damned one of the mystery sounds with a pound sign—there wasn't a rest symbol on my keyboard—and transcribe all the rest. The name of the language is spelled L-h-#-g-h-m-a-w-t-h-#. We don't know what the two pound signs represent, but it doesn't matter; we know that word now, and we can work with it."

"But if you do it that way," asked the senator she had put on hold before, "then how can you pronounce the words?"

"We can't," she said. "But it doesn't matter. We'll never be able to *speak* Moth—it has sounds in it that aren't possible as part of language for human beings, and we'll never be able to learn them. But we can use the language to communicate, all the same. You wear your computer, you see, in the usual way, and the computer transcribes Moth as it's spoken and prints it out for you. Soon it will print out a translation for you too, because we will have programmed it with the grammar of the language."

"And if you want to say something *to* the . . . uh, the Goldie . . . in Moth?"

"No problem. You speak Panglish, the computer translates it and prints it out as Moth, and you hand the printout to the Goldie to read. The same way native speakers of English can easily read written English that has misspellings in it or has coffee spilled on it, native speakers of Moth can read their own language even when it's full of rests—full of pound signs. It's not elegant, and it's not perfect, but it works."

"Are you sure?"

"Absolutely sure, Senator."

"And we'll never be able to speak it? Even if we appropriate enough money for USCOL to hire more linguists to

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work on it?"

"The human brain can't process those sounds, Senator. So what? I don't have three arms, either, but I don't worry about it. Different humanoid peoples will have different characteristics; that's to be expected. "

She could see them thinking; she could see them coming to a sensible conclusion. Before that could happen, Oka spoke up and lied to them.

"Do appropriate the extra money, though," she said, summing up. "We need more linguists to work on it. The more we learn about it, the more likely it is that we'll be more efficient with the next humanoid ET language we run into, instead of getting hopelessly stuck."

She was lying. There was no reason to think that anything they learned from Moth would be any use at all with the next humanoid ET language. But that was all right, and she kept her face carefully bland and confident.

The lie was A. Oka didn't know what Z was going to be, but she was sure that it would be worth the leap. ■

IN TIMES TO COME

Time Ablaze," by Michael A. Burstein, our lead novella and cover story for June, commemorates the 100th anniversary of a real but largely forgotten event. Before 9/11/01, the fire that destroyed the steamboat *General Slocum* was the worst disaster in the history of New York City, claiming approximately a thousand lives. Historians, of course, like to make past events as real as possible, and future science and technology may provide new ways to do that. But when you really get into such things, it can be hard to maintain professional detachment. . . .

The prolific and versatile Richard A. Lovett provides the fact article, with a self-descriptive title aptly alluding to that of a well-known story: "The Transience of Memory: We Really Can Remember It for You Wholesale." Lovett also has a story in the issue, as do such favorite writers as Stephen Baxter, Kevin J. Anderson, and Grey Rollins.

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This story contains scenes that may be disturbing to some readers

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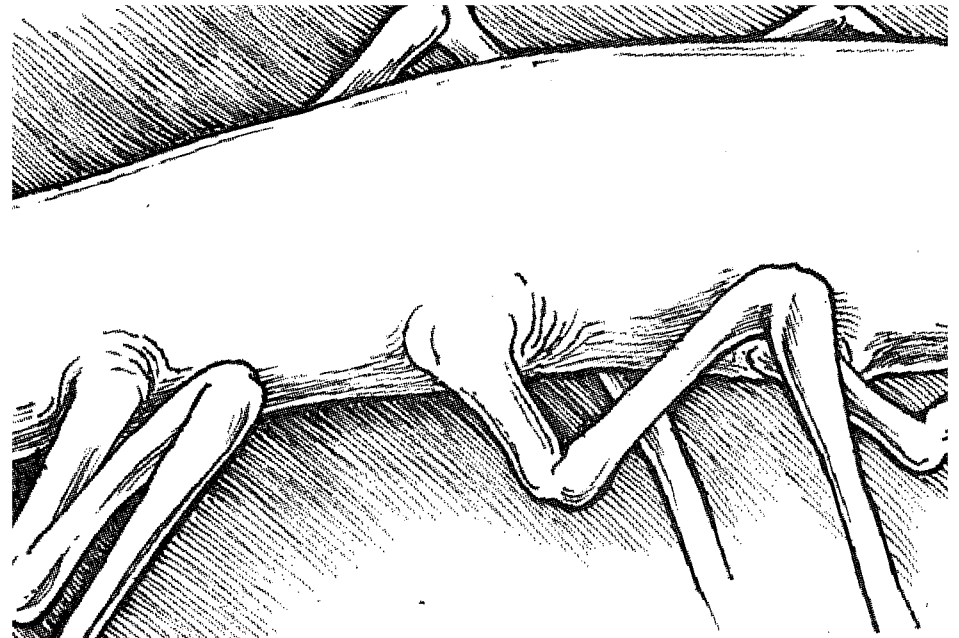

CAMOUFLAGE

Conclusion

Joe Haldeman

Illustration by Wolf Read

"Finding your roots"
can lead to *big* surprises!

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What has gone before—

Part 1

In 2019, an artifact from outer space is hauled up from a deep Pacific trench, from underneath fossil coral a million years old. A private research team, headed by Russell Sutton in an uneasy collaboration with shady millionaire Jack Halliburton, has claimed salvage rights and set up shop on Apia, Independent Samoa, far from the American government's prying eyes. They don't know what the thing is, but if they can crack its secrets, it should mean billions of Eurobucks.

Smaller than a delivery van, the streamlined metal mystery weighs more than a Polaris-class submarine. An industrial diamond drill won't mark it; no solvent or torch can even blemish its perfect mirror surface.

The thing it brought to Earth, called ***the changeling****, has spent most of its life as a sea creature. With some difficulty and pain, it can make itself look like anything. It doesn't remember the artifact, or indeed much of its past million years of life.*

*Unbeknownst to the changeling, the Earth harbors another extraterrestrial creature, unrelated, that shares some of its powers—****the chameleon****, able to look like any male human, but with a propensity for looking large and mean.*

In 1931, the changeling tries on a human body for the first time, and gets into a lot of trouble, but eventually decides it's more interesting than being a grouper or a shark. It tries various identities and decides to become a scientist.

In 1941, the changeling joins the U.S. Marines and goes to fight in the Pacific. It winds up dying several times and experiencing the horrific stress of the Bataan Death March.

Part 2

Fed up with the war, the changeling jumps into the sea and changes into a great white shark, setting its sights for California, ten thousand miles away—its first step on a path that will lead to Samoa and its destiny.

The changeling enjoys a lengthy vacation from being human, arriving back to the California shores in 1948. After looking around, it decides to take a cover identity of a kid from Iowa, and enrolls in Berkeley to study literature. "He" switches to anthropology about the time the UFO rage begins. He's skeptical.

The chameleon is also interested in the UFO question. It takes a more direct route, murdering an officer involved in the research and replacing him. The data doesn't prove anything, and after a couple of years, it leaves.

In the '60s, the changeling and chameleon happen to be in Cambridge, Massachusetts, together, neither aware that there's another alien in town. The changeling earns an astrophysics Ph.D. at Harvard; the chameleon studies engineering at MIT, and joins the U.S. Navy OCS to go shoot big guns into Vietnam.

Having had his fill of war even before Bataan, the changeling works for Project OZMA for a couple of years, searching for extraterrestrial intelligence, but then gives that up for a few decades of odd jobs: exotic dancer, short-order cook, palm-reader, surf bum, circus juggler. In 1996, it returns to the study of marine science, and also to the Pacific, studying and working in Australia.

Meanwhile, the chameleon has decided to make a fortune, leveraging blackmail income it earned as a male prostitute into various high-tech investments. It becomes the richest man in the world, its fortune diffused among over a hundred identities, and retires from investment the year before the dotcoms tank.

The Poseidon Project people on Apia have been more and more invasive in testing the artifact, and finally, through

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an arrangement with NASA, they borrow a huge offensive laser from the American military. They suck all the air out of the testing chamber and zap it with enough energy to stop a tank from orbit. It reacts by floating up in the air, light as a feather, and dropping on the laser with the mass of an apartment building.

The protective shell around the artifact is beefed up considerably, and they try something less aggressive—communicating with the thing using a Drake-style dot-and-dash message. No luck. Maybe repeat the experiment while changing the environment of the chamber to match various planets—let it know they're trying to make it feel at home.

The changeling, as Professor James Coleridge, has become a fairly well known authority on certain aspects of oceanography. When he reads about the Poseidon Project, he of course tries to join it, but they aren't hiring scientists; they have plenty of their own.

It's tempted to say "You want an expert on alien life? Here I am," but knows human nature and the government mentality too well to be that direct about it. It comes to Apia as an attractive woman angling for a job as a laboratory assistant, and after some delay, it's hired. It finds out that the artifact has responded, but with a digital sequence nobody has been able to decipher.

The chameleon has also come to Apia, in search of another shapechanger, but things are dull. It flies over to American Samoa to indulge itself in a murdering spree, and comes back undetected.

CONCLUSION

37. Apia, Samoa—13 June 2021

Trying to crack the artifact's code was the most interesting thing the changeling had ever done. If it could just be locked up in a room for awhile with the string of ones and zeros—and a data line to the outside—it could decipher the thing by itself. Whether that would take a week, a year, or a millennium, it didn't know. Or care.

But the others were fighting the clock. Jack wanted the thing cracked while it was still news, and so if the lid stayed on it, they would announce the communications breakthrough one day, and the translation the next.

To help guard the secret, he upped the ante: there was a million-dollar bonus to the person or team who broke the code, as long as its existence stayed secret. Otherwise, the prize went down to a hundred thousand.

The changeling wondered what the man's logic was, or whether logic had anything to do with it. Why was he so sure there would be money in this? If the message just said, "Hi; here are some pretty pictures in return," and gave up nothing more revolutionary than what we had given it—which was what the changeling and most of its coworkers expected—then how was Poseidon going to make a dime off it? T-shirts and action figures?

When the changeling broached that question to Naomi, she squinted and put a finger to her lips. "Ours is not to reason why," she whispered.

The number of ones and zeros was 31,433, which was not the product of two primes, but rather of three: 17 X 43 X 43. So it might be seventeen squares, each 43 dots and dashes on a side, or 43 rectangles arranged any number of ways. Or just one line of 31,433 bits of information, which might or might not be totally random.

Their computers could marshal powerful decryption tools, and no doubt if the government got into it, they would have much more sophisticated ones. But the assumption had to be that this was not a *hidden* message, at least not hidden on purpose.

This is where intuition came in, or maybe plain dumb luck. Twenty people

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were working on it, and they had twenty large flatscreens and five 1.5-meter cubes, for visualizing in three dimensions. Find something that looks like a coherent message, or at least part of one. The rooms they worked in looked like crossword-puzzle nightmares, white and black squares and cubes in constant chaotic dance.

The changeling "felt" something—it was not logic, certainly not numbers, but a sense that the thing really was trying to be clear. It was just so inhuman that humans couldn't get it.

Maybe the changeling had become too human itself, to get it.

People hungry for the million were grinding themselves down on coffee and speed and no sleep, so Russ declared a "snow day." Everybody stay home and sleep or otherwise relax. Jack had to go along with it. After five days, people were getting a little crazy.

The changeling spent its snow day walking up the hill with Russ. They agreed not to talk about the project at all.

"Up the hill" was the steep four-kilometer hike to Vailima, the mansion where Robert Louis Stevenson had spent his last years. Russ had been there a couple of times, and so was "native guide" to Rae.

The changeling probably knew more about Robert Louis Stevenson's writing than everybody else on the project combined, by virtue of its English major some lifetimes before. But it played dumb and let Russ educate it.

It decided that it had read *Treasure Island*, *The Strange Case of Dr. Jekyll and Mr. Hyde*, and nothing else by Stevenson. So as they trudged up the hill, Ross told her the stories of *Kidnapped* and *The Master of Ballantrae*, and some of the complex story of Stevenson's life on the island.

The changeling knew most of it, but was a good listener. How the great writer had come out here seeking relief from tuberculosis, and found not a cure, but a relaxed and relaxing style of life. He, or his wife Fanny, imported a lot of things that made Vailima a transplanted corner of civilized Scotland: fine linens and china, a good piano that was rarely played, walls lined with books—even a fireplace, in case the Earth changed its orbit.

It would be a better story if Stevenson had written any of his classics here, but those were behind him. He did write five books, and threw great parties, for the Samoans as well as the Anglos and Europeans. He found people to love, a condition that Fanny may have been resigned to before they moved, and his last years were full of joy and ease.

The changeling was not seducing Russ; it was just being there. But that was sufficient. Russ had never been immune to attractive women, and he was at a stage in life that was like Stevenson's, minus wife and illness, plus good genes and all the benefits of twenty-first century medicine. His body and mind were young enough that a liaison with a thirty-year-old woman was not ridiculous to either of them. As they pounded uphill together, sweating and laughing, stopping for a beer at a little joint, the difference in age became a novelty rather than a barrier.

They walked through Stevenson's mansion, shoes off, with a teenaged Samoan guide who hadn't read much of the author's work, but knew everything about daily life on the mansion, and talked as if Stevenson had just stepped out for awhile, perhaps riding down to Apia to see what the latest freighter had brought in, or joining the native workers in farm chores or clearing brush—she claimed that in spite of his physical problems, he took special pleasure in working to exhaustion, because afterward he could sit and look at the beauty of the forest and the distant sea, and truly enjoy it, his busy brain stilled. After the guide left, Russ said that he hoped it was true, but doubted it.

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Not for the first time, the changeling wished it had discovered humans before 1932. It would have been interesting to watch the centuries go by; see how people changed.

After the tour, they climbed farther up the mountain, to where Stevenson and Fanny were buried. On his stone, the familiar inscription:

Under the wide and starry sky,
Dig my grave and let me lie;
Glad did I live and gladly die,
And I lay me down with a will.
This be the verse you grave for me;
"Here he lies where he longed to be;
Home is the sailor,
home from the sea,
And the hunter home from the hill."

"I wonder if he really meant that," the changeling said. "'Gladly die.' Was he that ill? Or maybe he was talking about the natural order of things."

"He was gravely ill," Russ said, "but it wasn't in Samoa. He wrote it in California, a long time before he got here and his health improved."

The changeling took his hand and they looked at the stone for a few silent moments. "So what do you want to do for the rest of your snow day?" it said.

"I don't know. We could build a fort and have a snowball fight."

It laughed. "I have a better idea." About a kilometer back down the hill was a quaint twentieth-century hotel, where they spent a couple of hours under a ticking ceiling fan, making love and then quietly sharing their life stories. Russ did most of the talking, but then he thought he had lived a lot longer.

They got back to the project just before dark, and for appearance's sake, went their separate ways, Russ going downtown for dinner and the changeling getting a sandwich at the beach concession.

The changeling assumed that their secret wouldn't be a secret for long; in fact, it was out before they left their hotel room, since the clerk had recognized Russ. In Samoa, gossip is a varsity sport, a high art. The clerk had a cousin who worked at the project, and every native employee knew some version of the story before Russ and Rae came down the hill. Everyone else would know in a day or two.

38. Los Angeles—25 June 2021

The fingerprints betrayed the changeling. The real Rae Archer had her driver's license renewed, and her fingerprints went into the Homeland Security database.

In a fraction of a second, a computer flagged them as identical to a set that was in a CIA database. The CIA thanked them for the information and said they would take it from here.

Everybody working for the Poseidon Project had unwittingly provided latent prints to a Samoan dishwasher who was employed by the CIA. When the CIA found that there were two Rae Archers with identical prints, one of them employed in a super-secret foreign scientific project, they went into high gear.

An apologetic man from the LAPD showed up at Rae Archer's place and said he had to do the driving exam fingerprints over; they'd been misplaced.

The real Rae Archer was pleasantly surprised that the state would come to her, rather than asking her to come back downtown, but wished they'd given her some warning; she looked a mess. The handsome officer didn't care, though, and neither did the woman in the car, behind the telephoto lens.

Back in Langley, in a bland building that had served the same function for sixty years, agents looked at the evidence and considered what was possible, what was legal, and what they would do.

They had several minutes of video of Rae Archer, somewhat harried mother of triplets, and six jpegs of Rae Archer, lab assistant in Samoa. They were at

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least superficially the same woman, a very attractive Japanese-American. That they shared features and figure was unusual; that they shared fingerprints and retinal patterns meant that the one in Samoa was a new kind of spy, perhaps a clone.

But who would bother to clone Rae Archer, and who could have done it, back in the '90s?

They asked around and confirmed that no, she was not one of ours, and no, the fingerprints and retinas were not in our bag of tricks. You could fake the retinal patterns by data substitution, but the fingerprints were pulled from a water glass the spy had handed to the dishwasher.

They desperately had to get her in a room and ask her some questions.

39. Apia, Samoa—15 July 2021

The changeling was interested and amused by people's changing attitudes toward Rae. Some obviously thought she was a shameless manipulator, or maybe just a nymphomaniac. A lot of the men were happy for Russ, the old dog, or ruefully jealous. Rae didn't wear makeup and dressed severely, at least in the office, but the men had her pegged as a hot number from the beginning. The ones who had seen her swimming had seen part of the rising sun tattooed over her shapely butt.

After the snow day, most people came back to work with renewed vigor. A few had not benefited from having a day to reflect on the lack of results—maybe it *was* time to bring the government in.

The government was coming in, but not for decryption.

Two CIA agents, masquerading as honeymooners, reserved the fancy Wing Room at Aggie Grey's for a week. Four other agents rented the flanking rooms. They had flown into American Samoa on military aircraft, and come to Apia on the ferry, so there was no nonsense about luggage being searched.

The seventh agent, a white-haired old lady, got a room at the bed and breakfast where Rae Archer was staying. An hour after maid service the second day, Rae's room was thoroughly bugged.

That surveillance did them no good. The changeling was automatically cautious, mimicking human behavior. It ate and drank and excreted at regular intervals, and lay down in the dark for eight hours every night. That it was analyzing 31,433 ones and zeros, instead of sleeping, would not be obvious to any observer.

They considered and rejected the direct approach, going straight to Poseidon and showing them what they knew about the mysterious employee. They knew she had a sexual relationship with the second in command, perhaps a love affair. And what they learned about Jack Halliburton did not make them optimistic about his cooperating with the American government. He had cynically used the American navy to put together a pool of talented specialists, hired them away, and quit his commission in an acrimonious scene. He wasn't even an American citizen any more.

The other direct approach, just snatching the woman off the street or from her room, had some merit—they didn't know it would be easier to "kidnap" a Powell tank—but as they had no legitimate jurisdiction here, they wanted to be a little more subtle. They used a lure, an indirect one.

Russ had dropped his business card into a box for a once-monthly drawing that awarded a weekend for two at Aggie Grey's, at either the Wing Room or the Presidential Suite. He won the Wing Room, the weekend after the honeymooners left.

They knew they would have to deal with Russ sooner or later. Best do it directly.

There were three possibilities: Russ would arrive first, or Rae, or they would come in together. The last was not likely, since they were still being discreet.

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But the CIA team was ready for any of the three, as well as the trivial case where neither showed up.

If Russ had come through the door first, they would have had to do some fast explanation. But it was the woman.

The changeling came into the sumptuous room and tossed its overnight bag on the bed, and went into the bathroom to check its hair. It heard a vague sound in the hall, which was a man shoving a wooden wedge between the door and frame, jamming it shut, and the plain sound of another door opening and closing.

It sped out of the bathroom and saw the man and woman who had just entered from the adjoining room.

"Don't make this difficult," the man said. "You know why we're here."

The changeling answered automatically while considering various options: "You tell me."

"You're not Rae Archer. But you match her so precisely that you must be a clone or something."

"I don't know what the hell you're talking about."

"We just talked to the real Rae Archer, in Pasadena. You're someone else."

"Who do you work for?" the changeling said.

The woman shrugged. "The United States intelligence community."

"So you have no jurisdiction here."

"We just want to ask you some questions."

The changeling picked up its overnight bag. "No." Halfway to the door it heard a rubber-band sound and felt a sting in the middle of its back. It reached back—revealing unusual suppleness—and pulled out a dart with plastic wings.

The man was holding what looked like a toy gun. "That won't hurt you. It will just make you a little groggy."

The changeling inspected the dart, sniffed it, and shook it next to its ear. "Seems to have a bit left."

"Doesn't take much—" the spy grunted, dropped the pistol, and fell to his knees. The dart was in his neck, deeply imbedded into the carotid artery. He managed to pull it out but his knees gave way and he fell over prone, arms and legs trembling and then twitching.

"You want to be careful where you inject that." The changeling tried the door, but it was stuck. It heard the soft sound of metal on leather, and in three leaping steps was on the woman before she could raise the automatic to fire. It jerked her gun hand sideways and heard finger or knuckle bones breaking just before the weapon discharged, almost silent, into the wall, and pulled it out of her hand.

She screamed and a small man swung out of the door to the adjoining room, pointing a double-barreled shotgun. The changeling leaped sideways just as the first hammer went down; and the hot blast just missed its face. It reached for the weapon and the second blast blew off its left arm at the shoulder.

In the reverberating silence, blood pulsing from the ragged stump, the changeling raised the pistol to point between the man's eyes. "Bang," it said, and dropped the gun.

Two steps and it vaulted the couch and crashed through the glass balcony door. It hit the balcony railing and tumbled over, falling onto the awning over the hotel entrance.

Russ was a half-block away, and had looked up at the sound of the shots. He saw someone slide off the hotel awning and hit the sidewalk hard, and come up running, bleeding from the stump of an arm.

It seemed to have no face, as if it had a stocking over its head. Russ rubbed his eyes.

It ran *over* the slow traffic, one step on the roof a southbound car, the next on a northbound, then onto the opposite sidewalk, over the low fence onto the harborside park, and while tourists and picnicking families gaped, it ran like an Olympic sprinter and was over the

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stone breakwater in a flat dive.

By the time anyone got to the breakwater, there was nothing but ripples. A siren threaded through the air.

The changeling sought shelter on the harbor bottom, under the shade of a tanker that was drawing half the depth of the water. It strained to become a fish as quickly as possible, bone into cartilage and denticles and teeth, muscle and guts into the streamlined swift form of a reef shark; bloody clothes left behind as a red herring.

The metamorphosis was just complete when it heard divers splash into the harbor back where it had dived in. It breathed a surge of warm salt water liberally flavored with diesel spill—delicious—and flexed itself in the direction of the open sea.

A helicopter commandeered by the police made a search pattern low over the harbor, and with binoculars and sonar found nothing but the usual assortment of fish and discarded debris, from the surface to the bottom. A couple of large sharks, one evidently spooked by the helicopter.

Russ hadn't recognized the apparition as Rae. Still trying to sort out what he had seen—there was a movie company shooting up in the hills; maybe they were using Aggie Grey's as a location for an action sequence—he stepped into the lobby of the hotel like a sleepwalker.

All the people at the registration desk were jabbering into phones. Two policemen with pistols drawn ran through the door and thundered up the stairs. While Russ was watching them, a man beside him said, "Russell Sutton?"

It was a short, stocky man who smelled odd. Gunsmoke? "Who are you?"

He held up identification. "Kenneth Swanwick. I'm a CIA investigator."

Russell shook his head. "I don't get it."

"Rae Archer is a spy. We—"

"Is this part of that movie?"

It was the agent's turn to be confused. "What movie?"

"The one they're shooting up by the waterfall."

He took a deep breath. "This is not a movie." He held up the ID again. "We used the raffle here as a ruse. We knew Rae Archer was a spy and wanted to catch her unawares."

"Come on. I *know* she couldn't be." But certain oddnesses began to crystallize.

"We picked her up to interrogate her and she killed one agent, injured another, and escaped by crashing through a glass door."

"That couldn't have been her. Maybe somebody who looked like her."

"That's exactly it," Swanwick said, "and we think we can prove it."

"Wait." Russell pointed out the door. "*That* was—"

"We don't know who that was. Claimed to be her. Looked like Rae Archer. Had her fingerprints."

"But—"

"But the real Rae Archer is still in California. We talked to her. She claims not to know anything about this, and I think we believe her."

They were joined by an attractive woman whose tense face was as pale as her ash-blond hair. She was tightening a bandage around her right hand. "This is Mr. Sutton?"

"Yeah," Swanwick said. "He's a little confused."

"Like we aren't." She was the same height as Russell and fixed him with her large gray eyes. The pupils were pinpoints from medication. "My name is Angela Smith."

"And you're a spy?"

"An investigator."

He stared at her weird eyes. "And this is not a movie."

"I wish to God it was. We could strike the set and start over." To Swanwick: "You're going to have to go with the police in a minute. There should be a

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lawyer by the time you get to the station." She swiveled back to Russell. "You knew Rae better than anybody else. You were intimate with her."

He nodded cautiously.

"We have to talk but can't go up to the room. Get in the way of the cops." She gestured toward the bar with her bandaged hand. "Uncle Sam will buy you a beer."

One of the few tables in the small bar was unoccupied. The bartender came over and took their order. The window that looked out over the park and the harbor showed a growing crowd of curious people, held back by two policemen in incongruous parade uniforms.

"Try to think of Rae as a spy," Swanwick said. "Did you ever get the feeling she was pumping you for information?"

That had an annoying alternate interpretation. "Not really," Russell said with some asperity. "We're both working on the same thing. We talked about it all the time. So does everyone else on the project."

"Think about it this way—ow!" Gesturing, she had bumped her bandaged knuckle. "She's supposed to be an astronomer. Did she seem like one to you?"

"No doubt about that. You'd have to ask Dr. Dagmar to be sure; she's our top astronomer. But Rae seems to really know her stuff, a lot more than me. I'm just a marine engineer, but I've been into astronomy all my life."

Swanwick nodded. "Did she show any special interest in defense or military applications of this thing? The artifact?"

He thought about that for a moment. "Defense? I can say no almost without exception, since that's an angle I'm not interested in. I'd remember if she tried to 'pump' me on that."

A policeman came into the bar, holding a sawed-off double-barreled shotgun in a plastic bag. Swanwick stood up.

"Did you shoot that woman with this?"

"In self-defense. She was—"

"Ya, ya." He gestured to a big officer behind him, who came around quickly with handcuffs.

"That won't be necessary," Swanwick said, but the big man spun him around roughly and snapped them on. "She had a gun," he said.

"And you had this in your room for the little mice," the first policeman said. He turned to Russell. "Dr. Sutton, please wait here with your lady. A man will take your statement soon."

They watched the three of them leave. "He shot her . . . with *that*?"

"Hit her, too. Blew off her arm." There was a moment of dead silence. The people at the other tables were looking at them. She let a breath out in a puff. "Speaking of 'ladies'?"

He pointed. "Behind the gift counter, down the hall to the left."

She picked up her purse. "I'll be right back."

Unsurprisingly, he never saw her again.

40. Faleolo, Samoa—15 July 2021

Once on the other side of the reef, the changeling stayed in the relatively deep water, plying west slowly toward the airport at Faleolo. There was a plane out the next day, to Honolulu.

It would take human form and come ashore after dark. Hide for awhile and then walk into the airport. Then go about the problem of getting a ticket, without passport or credit cards. It could create counterfeit cash, but even under normal circumstances, it would look suspicious to try to purchase an expensive ticket with cash. Maybe a Samoan could get away with it, but it didn't know the language well enough to pass among Samoans.

Eighty or ninety years ago, it would just isolate someone, kill him, and use his identity and ticket. That was repugnant now. Maybe the man who shot Rae's arm off. The world might be a better place without him.

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By the time it got to Faleolo, it had a better plan. Not without risk, but it could always escape into the water again. They'd eventually catch on to that. But it had escaped from a few jails in its time, too.

It went a half-mile past Faleolo, to get away from the light. The moon, not yet first quarter, was no problem. The changeling sat in the shallows and changed.

About a pound of its substance became a plastic bag full of circulated fifty- and hundred-dollar bills. Another twelve pounds, a light knapsack with a change of dirty clothing and a wallet that had enough Samoan tala for a few cab rides and a night of drinking, with an American Universal ID and a California driver's license, matching the persona it painfully built. Newt Martin, a common type of denizen in this corner of the world. Young, restless; escaping from something. Money enough for food and drugs and a flop, and maybe a little more. Maybe a lot.

It made a passport that would pass visual inspection. The computer at Passport Control wouldn't be fooled.

About 8:30 it crept ashore, squeezed the water out of its long blond hair, and walked down to the airport. It got into a cab and told the man to take him to the clock.

It was a simple plan of action. Find a young American desperate enough to temporarily "lose" his wallet and passport and ticket out, in exchange for a lot of money. The kid wouldn't find out until later that there was a little more than that involved.

"The clock" is an early twentieth-century tower in the center of town, the main landmark. The changeling paid off the cab and walked down Beach Road toward the harbor. It knew there were some seedy-looking bars about halfway to Aggie Grey's, but it had never been inside one. "Rae Archer" wouldn't have done that. Newt Martin definitely would.

Bad Billy's looked promising. Smelled right even from the sidewalk, spilled beer and stale cigarette smoke. Loud rap music from twenty years ago. The changeling sidled in through a mass of people standing in the door, for the air, and went to the bar. There were only two other customers there, the rest of the clientele either shooting pool or sitting in clusters of folding chairs around small tables full of drinks, talking loudly in two languages. Its keen hearing picked up a third, a French couple away in a corner, whispering about the scene around them.

One of the English conversations was about the strange goings-on at Aggie's today. One of the Samoans had a friend in the police, and he said that he said it was an industrial espionage deal that had gone bad.

Right, somebody said—shotguns and old Jackie Chan super spies. It was just a publicity gag for the movie.

Wanting to draw attention, the changeling ordered a double martini. It had to explain what that meant, and wound up with a half-liter glass of cheap gin and ice with a quarter lime floating on top. (Having been a barmaid itself, it knew the smell of cheap gin. This stuff came in big plastic recycled soft drink bottles from a distillery outside of town.)

The flavor was interesting, reminiscent of the underwater taste of bilge and oil spill.

An aromatic Samoan prostitute came over next to him. "What ya drinkin'?" She was still young but getting puffy.

Put an egg in your shoe and beat it, the changeling thought. Chase yourself, get lost—working up through the decades—bug off, fuck off, haul ass, twist a braid, give air. Instead it said, "Martini. Want one?"

"What I have to do for it?"

"You're not what I need."

She haunched up on the stool, short skirt casually revealing no underwear.

"I know some guys . . ."

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"Not that." The changeling got the barmaid's attention; pointed a finger at its drink and then at the space in front of the girl. "You know where the drug action is?"

"Oh, man." She looked around. "Cops everywhere tonight. That thing at Aggie's."

The barmaid brought the drink and the changeling made a show of riffling through the thick wad of bills to find a twenty. "I've been out of town. You see it?"

"No, man, it was noon. I hadn't got up yet." She stared at the wallet until the mark put it away. "I could bring you anything you want. You shouldn't be on the street, man, cops're pickin' up any palagi they don't know." White man.

"Hold it here a minute." The changeling went back to the men's room, a single noisome stall, and sat in the dim light, changing slightly. It went back to the bar with the same features, but dark skin and black hair.

"Now that's somethin'." She rubbed its cheek with her fingertip and looked at it. "How long it last?"

"A day or two. So what happened at Aggie Grey's, do you think?"

"Say it looked like a stunt-man thing. Some gunshots and then this guy crashes through a window, bounces off the whatcha-callit over the door—"

"Awning?"

"Yeah. Then runs like a bat outa hell across the street and the park and jumps in the harbor. Looks like he got his arm blown off, blood everywhere, but it don't slow him down, like special effects."

"The movie people say anything about it?"

"They say it's not them, but you know, bullshit."

"Yeah. Drink up and let's go."

"Where?"

"Dope. Dealers." The changeling drank off half the martini in one gulp. The girl tried, and went into a coughing fit. The barmaid brought some water and gave the changeling a sharp look.

"Maybe that's enough," it said when the girl quieted down and was breathing more or less normally. "Don't know what they make this stuff out of, anyhow."

She sighed and nodded and slid off the stool unsteadily.

"There's a party. I take you there, you meet some guys, you take care of me?"

"What does that mean?"

"Like a hundred bucks?"

"We'll see." It took her shoulder and aimed her toward the door. "If I score, sure."

They walked along Beach Road a couple of blocks and then down an unmarked gravel alley. She stopped at a Toyota that had more rust than paint, and jerked the driver's side door open with a shriek. "Here we go."

"You okay to drive?" The door on the changeling's side didn't open. She leaned across and pushed hard twice.

"Yeah, yeah. Get in." It smelled of mildew and marijuana.

On the third try the engine, older than the driver, sputtered to life, and they jerked on down the lane. She drove with a drunk's elaborate caution, weaving.

"You don't want me to drive?" It couldn't die, but it didn't want to attract attention from police by not doing so.

"Nah, this is fun." She found her way to the winding uphill road that the changeling recognized as the one leading up to the Stevenson mansion. Traffic was light, fortunately. The girl didn't say anything. She was concentrating on staying near the center of the road.

They passed Vailima and came into a woodsy area with no homes near the road. "Look for a orange plastic ribbon on your side," she said, slowing to a walk. "Tied to a tree. 'Round a tree trunk."

"There it is," the changeling said, and then realized human eyes wouldn't see it yet.

"Where? I don't see." She peered over

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the steering wheel and the right wheels crunched into gravel. She overcorrected well into the oncoming lane, forcing a Vespa off the road. The rider yelled something in Samoan but rode on.

"Trust me. It's up there." After another couple of hundred yards the headlights caught the pale orange ribbon, sun-bleached emergency tape. She pulled into a dirt road just beyond it.

"You got some eyes." They could just see the road ahead, and the changeling held on. They splashed into potholes so deep the springs bottomed out with a clunk and the driver hit her head on the roof, laughing.

They came to a western-style house, an incongruous rambler, a little light coming from behind drawn blinds, lots of cars parked in the circular gravel driveway. There were clapped-out hulks like the girl was driving, but also new cars, two taxis, and a shiny limousine.

Too many people, the changeling thought. Be careful.

They picked their way up a board walkway set on the muddy ground. Pine smell of construction; latex paint. The house was new. Business must be good.

She leaned on the doorbell and the front door opened a crack. A tall black man looked down at her. "Mo'o. You found some money somewhere?"

She jerked her thumb in the changeling's direction. "He's got plenty."

The black man looked into its eyes for a long moment. "Why should I trust you?"

"You shouldn't. I don't know anybody local. The slit said she'd take me where I could find some dealers."

"You buyin' or sellin'?"

"Right now I'm buying."

"Let me see some color." A flashlight snapped on. The changeling opened his wallet, fanning bills. The man murmured, then flashed the light in the changeling's face.

"We'll take a chance." He opened the door part way. "You know if you're a cop, your family dies, in front of you. And then you?"

The changeling shrugged. "Not a cop; no family." He passed through but the man stopped the girl.

"I got money," she protested. "*He's* got money for me."

"A hundred bucks," the changeling said, and took two fifties out of his wallet, and passed them back to her.

The black man let the money pass but still blocked the girl. "Go home, Mo'o. I don't need any more trouble from your matai."

"I'm over 21 and she's a bitch."

"You're drunk. Sleep it off in the car."

"Wait for me in the car," the changeling said, waving her away. "Give you another hundred if I get what I want." She walked away, mumbling and staggering.

Inside, it looked like the party was over but nobody'd gone home. There were about fifty people standing, sitting or passed out. A table with food and bottles of wine and liquor was a picked-over mess. The air was gray with smoke: The changeling sorted out cigarettes, expensive as well as cheap cigars, the burnt-plastic smell of crack and the heavy incense of hashish. No one was smoking heroin, but there were plenty of needles in evidence; on the buffet table three hypodermics stood point-down in a glass of clear liquid.

The room had an unfinished look, walls freshly painted with travel posters and Gauguin reproductions thumb-tacked here and there. New cheap furniture in a haphazard scatter.

"So what can I get for you?" the black man said.

"Hash, I guess." The changeling thought back to its circus days. "You have squiddy black?"

"Dream on. Most of these guys smokin' slate."

The changeling shook its head. "Nothing Moroccan. What you got Asian?"

"Red seal and gold seal. Cost you."

"Little bag of gold seal, how much?" He said $250 and the changeling got

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him down to $210.

It took the stuff and a glass bong to a folding chair in a corner where it could survey the room.

The hash had an interesting flavor. It burned hot, probably because of additives. A little asphalt.

The changeling was looking for someone who looked like he was used to having money, but was down on his luck. Preferably someone not native; about a third of the men qualified on that score.

An American would be preferable; one who resembled the changeling would make things easier to explain. There was one light-skinned black man who was fairly close to the changeling's current appearance, though a few inches taller and considerably heavier. He was sitting backwards in a folding chair, chin resting on forearm, intently following a lazy argument two men were having, sitting cross-legged on the floor. Good clothes that needed dry-cleaning.

He was holding an empty bong. The changeling padded over and sat on the floor next to him, and relit the resin in its bong.

"So what do you think?" one of the arguers said to the newcomer. "How old is the universe?"

"Thirteen point seven billion years. I don't remember half that far back, though."

The other one shook his hand. "Close. Sixteen billion."

"He's using the Torah and General Relativity," the black man said. "Smells good."

The changeling held out the packet to him. "Gold seal; have a hit." To the Torah guy: "I could spot you 2.3 billion. That's six really long days."

He launched into an explanation about how small the universe had been back then. The other arguer stared at him with an expression like a spaniel trying to stay awake.

The black man broke off a little piece, rolled it into a ball, and sniffed it. He nodded and handed the bag back. "Thanks."

The changeling lit a wooden match and held it up for him. He breathed the smoke in deeply and held it. After a minute he exhaled slowly and nodded satisfaction. "So what are you after?"

"What, you don't believe in spontaneous acts of sharing?"

"You aren't fucked up enough to be spontaneous with gold seal."

"That's a good observation."

"So you want something, but it's not drugs. Must be sex or money." He shook his big head slowly back and forth. "Don't have either."

"There is one other thing." The changeling stood up, feigning difficulty. "Talk outside?"

He nodded but stayed put. He held up one finger and stared at it. "Oh, and I can't kill anybody. Don't want to go through that again." The two chronologists looked up at that, faces masks.

"Nothing like that. Come on." The man got up and walked with exaggerated care, perhaps more stoned than he looked or sounded. The changeling told their host they'd be right back.

Some animal scampered away when the door opened. Otherwise the dark forest was silent except for water dripping.

"This is the score. I have to be on the plane to America tomorrow. But I don't have a ticket or a passport."

The man squinted at him in the faint light from the shaded windows. "Okay?"

"So do you have a passport?"

"Course. But no way you could pass for me."

"That's not a problem. I've done this before."

"But then I'm stuck here. What do I do about *that*?"

"Nothin' to it. I'll mail it back to you, overnight, from LA. But you don't have to trust me. If you don't get it, wait a few days and you go to the embassy and report it lost. They'll check you out and issue a temporary; you can replace it when you get back to the States."

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"I'd have to think about it. How much?"

"Five thousand up front, plus the cost of a ticket. They probably just have first class open; that'll be a thousand.

"But I'll give you five thousand more if I get to LA with no problem. Send it in a package with your passport."

"For that part I just have to trust you? A total stranger I met in a hash house?"

"Think of it as my insurance policy. It's not in my interest to have you report your passport stolen."

He was lost in thought, sorting that out. The changeling took the opportunity to stare into his dark-dilated eyes and duplicate his retinal pattern, in case.

"You throw in two bags of gold seal and you've got a deal." They shook on it, the changeling getting his fingerprints in the process. Then it wrote down an address for the cash and passport return.

It had him wait in the doorstep and went back in to score the hash. The man said $400 and stayed with it; no deeper discounts unless you want a lot more. Ten bags would only be $1500. The changeling declined and left with the two.

His partner in crime wanted them right away, but the changeling said no; not until I have the ticket in hand. They crunched down the driveway to the rusty Toyota. The young prostitute had reclined in the driver's seat and was deeply asleep, snoring softly. The changeling gently transferred her to the back seat and took the keys from her pocket.

The black man also slept while the changeling drove back into town. It wanted to avoid Beach Road and downtown; the police probably would recognize the car, and might wonder why he was driving it. It didn't know the back roads, and so proceeded by dead reckoning, bearing roughly west and south until it came to Fugalei Street, which it knew would have the Maketi Fou, central market, on the right and nothing but swamp on the left. Then it hit the beach at the flea market on the edge of town and turned onto the airport road.

It was a half-hour of slow driving, the changeling easy on the speed bumps, to keep its crew asleep. The airport was brightly lit, and there were lots of cars and cabs waiting. The airplane that it would take it out tomorrow would be landing in about an hour. It remembered that, the late hour notwithstanding, the ticket office had been open when it had arrived the month before.

The black man rubbed his eyes and yawned; no room to stretch. "So. You give me the money. I go in and get myself a ticket to LA; bring it back and collect my hash."

"Close." The changeling handed him a roll of bills secured by a rubber band. "But I'm going to keep you company. The hash stays here, in case they have dogs or sniffers. We come back here. You give me the ticket and passport; you keep the change and the hash. I drive you back into town." The changeling pulled into a space close to the waiting area.

"Okay up to the driving. I take a cab back."

"What, you don't trust me?"

He snorted. "Once you have the ticket and passport, I'm more use to you dead than alive."

"I hadn't thought of that," the changeling said honestly. "You must know the criminal mind better than I do."

"'Ask the man who owns one,'" he said. They got out and walked into the building. It was open-air, no walls on the ground floor.

There were dozens of people sitting around on plastic chairs, reading or watching television. A group of teenaged boys and girls in traditional garb chattered happily. They would be the song-and-dance welcome for the flight from the States.

The changeling went upstairs to the bar while his accomplice approached the ticket counter. There was no line

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and only a single agent, making no effort to appear happy or alert.

It got a beer and sat near the stairway, where it could watch the transaction. It could imagine what would happen stateside, if you walked up after midnight and tried to buy an international ticket with fifties and hundreds from a thick roll, no luggage.

The young woman treated it as if he were buying a loaf of bread, though she looked at his passport.

Back at the car, the changeling checked the passport and ticket, and handed the black man the keys. "You okay to drive?"

"If I go as slowly as you did, yeah. You staying here until the flight?"

The changeling reached over the back seat and stuffed a bill into the girl's shirt pocket. "Go back to the hash house and don't tell anybody where you've been."

"I might just go back and get my car, and head home. Enough excitement for one night. What if the girl wakes up?"

The changeling considered. "Best just tell her you dropped me off at a house in town. And . . . don't come back to the airport tomorrow. That could be awkward."

"Yeah. I already figured that out." He started the car, then shook his head. "This is crazy."

"Just keep an eye on the mailbox." They exchanged stares for a moment, and the man drove off.

The changeling had a few things to do, but there was no rush; the gate didn't open till twelve. It went back inside and left passport and wallet in a storage locker, and then set out to find twenty pounds of flesh.

In the daytime it would have been easy; just go into a supermarket and buy twenty pounds of meat. It didn't want to chance taking someone's dog or pig, so it had to be the sea.

It walked back to the road and headed away from town. Everyone had gone to bed and clouds covered the stars; between headlights the world was black as pitch. The changeling came to a path that led to a stone beach, and slipped quietly into the water.

There was no need to masquerade as a fish. It just stretched its feet into something resembling swim fins, unhinged its jaws and made its mouth and throat wide enough to accept a large fish. It glided out to the reef and looked around with nose and skin more than its large eyes—like a shark, it could sense the change in electric potential that meant a large fish in trouble.

That was the meal ticket—it felt the slight tingling and went straight toward it, and came to a reef shark wrestling with a skipjack tuna half its size. The changeling killed the shark with a big bite, severing the notochord, and easily chased down the crippled tuna and ingested it in one gulp. Then it went back and consumed the shark.

The two of them had provided plenty of mass. It swam back to the shore, grew feet inside shoes, and walked back toward the airport, a large white American, and took a cab into town.

Bad Billy's was still open—it advertised being the last bar to close in the Western Hemisphere—but the changeling didn't want to attract attention, so it had the cab stop at the first vacant motel, the Klub Lodge, where it took a small room and lay thinking for some hours.

It hated leaving the artifact, and considered just presenting itself to Russ for what it was: obviously from another planet, and possibly related to that impossible machine. But it didn't want to wind up a specimen to be examined, and they could probably infer enough about its abilities to build a cage from which it couldn't escape.

It wouldn't be smart to hang around Samoa. The island would be thick with U.S. government agents in another day or two, once they figured out what they had almost caught. Even if they *didn't* figure it out, and thought the changeling was some sort of augmented human or

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spy machine, they'd still be all over the island trying to track it down. It hoped they were looking for a one-armed woman.

It waited until almost ten to walk into town; the sidewalk was crowded enough that it didn't stand out particularly, just another sunburnt tourist. It had earlier, as Rae, found a Goodwill store; it went straight there and bought a suitcase and a few changes of clothing. At a more touristy place, it bought a couple of bright skirts and a souvenir lava-lava. An assortment of toiletries from a convenience store, and a couple of gift bottles of Robert Louis Stevenson liqueur. In a coffeehouse restroom it disposed of some of the toothpaste and shaving gel, so they wouldn't look just-bought, and caught a cab to the airport.

There were three uniformed policemen on duty, and one Samoan woman in a business suit pretty obviously surveying the crowd. It occurred to the changeling that its choice of identity might have been disastrous, if Scott Windsor Daniel, African-American hash hound, was known to the police.

Best done quickly. The changeling went into a crowded men's room and waited for a stall. Once behind the door, it went through he uncomfortable business of changing its face and hands to match Daniel's. It also changed shirts, putting on a souvenir one that, under the circumstances, acted as protective coloration.

The whole business took fifteen minutes. If anyone noticed that a white man had gone in and a black man had come out, they didn't say anything.

The first test was Passport Control. A native woman checked documents and retinal scan, and collected departure tax, but the woman sitting behind her in the booth, right arm in a sling, was the one from "the United States intelligence community," who had almost put a bullet into Rae the day before.

Neither of them paid any special attention to Scott Windsor Daniel, so maybe they actually were looking for a woman. A small white one with a missing arm? They did do a fingerprint check, though, as well as the usual retinal scan. The spy woman put on a jeweler's loupe and, glancing, clumsy with one hand, compared the thumbprint to one on a card.

Security was likewise easy, which was encouraging. It hadn't occurred to them that they were looking for a shapechanger. They sorted through Scott's unremarkable luggage, wanded him, and sent the suitcase down a chute and him through an optical baffle into the multilingual murmur of the waiting room.

It sat at the bar and nursed something they claimed was Chardonnay, leafing through the Samoa *Observer*. The disturbance at Aggie Grey's was the front-page story, with an interesting twist—the movie people "were not at liberty to say" whether it was part of the thriller they were filming. Presumably someone had coached them; they *were* an American company, and the government could hassle them if they didn't cooperate. Though it could be that they came up with the evasiveness on their own, latching onto free publicity.

Interviews with Aggie Grey people and the police were not much more informative. Some tourists agreed that the "man" who ran across the park and dived into the harbor appeared to be one-armed. Their consensus was movie.

Hard to plan with so little information. The flight switched to Delta in Honolulu, and there was a six-hour layover. It might be prudent to switch identity again there, in case they'd picked up the trail to Daniel. If they had, there would be a greeting party at LAX. If Mr. Daniel didn't show up there, they would no doubt smoke the real one out in Samoa.

Or they might be waiting in Honolulu. What would it do? The airport wasn't too far from the sea, but harder to emergency-exit from than the Wing Room at Aggie Grey's. They would presumably

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be expecting someone with unusual powers—depending on who "they" were. The spies might not have told the police everything. So one scenario was "police looking for a drug dealer with Mr. Daniel's passport," which wouldn't be that hard to step around.

It set that problem aside, and returned to its usual mental occupation, analyzing 31,433 bits of information. Or noise. It continued its methodical way through those gazillion permutations as it filed through early boarding, took its seat in first class, and selected a random movie on its monitor. It nodded for champagne and made rote responses to the attendant's rote queries.

If it spent one second on each possible combination of the 31,433, it would take about as long as the Roman Empire. The changeling did have the time, but it was hoping that some sort of pattern would emerge long before that.

It had no seating companion, so the time went quickly, in a blur of ones and zeros. It came out of its five-hour reverie when the landing gear hit the tarmac in Hawaii.

First class exited democratically, allowing one *hoi polloi* interleaved between each of the elite, and the changeling entered the airport with a neutral expression, looking around with no particular interest, just a guy changing planes, who had to go through the inconvenience of passport check and baggage transfer.

There was nothing unusual at first. But then he saw that every "US CITIZEN" checkpoint was protected by a large policeman, standing between Passport Control and the luggage check.

Maybe they were always there. He didn't remember them from earlier flights, when he was going back and forth between Australia and the States. It would be better not to take the chance.

There were two bathrooms, for the convenience of people who were willing to take a later place in line, in exchange for comfort. The changeling angled toward the men's. Its timing was good.

As it entered the privacy baffle between the corridor and the men's room, an attendant with a cart was backing out of a utility room. A glance confirming that there were no witnesses, it covered the man's mouth and nose and shoved him back into the room.

It punched him on the chin just hard enough to daze him, and slapped on the light. It was a room about the size of a walk-in closet, with racks of supplies. It plucked a roll of wide duct tape and carefully pressed a piece of it over the man's mouth, and squares over each eye. Then it undressed him and put on his uniform, and bound him tightly with tape.

It took his retinal pattern and fingerprints, studied him for a moment, and then turned out the light and concentrated on becoming him. It wasn't too painful, skin color and facial structure. Then it pushed its way out behind the cart, leaving the door locked.

How much time did it have? If those cops were waiting for Mr. Daniel, it was only minutes.

It hesitated by a door that said AUTHORIZED PERSONNEL ONLY, trying to imagine what might be behind the sign. It could be the place where janitors go to catch a smoke. Or it might be full of nervous security types.

Turning the cart around, it headed back toward Customs. There were six lanes open for U.S. Citizens, and three for foreigners—and one marked "employees."

It got halfway through the short lane, and somebody shouted, "Hey! Asshole!"

It stopped and turned around. A fat cop said something angry. It was in Hawaiian, unfortunately.

It shrugged, hoping that not everyone who looked Hawaiian spoke Hawaiian. "You know the drill," he said. "Where the hell you goin'?"

"Just out to the car," the changeling said. "My dinner is in the cooler."

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"Yeah, *liquid* dinner. Just leave the goddamn cart on this side, okay?" The changeling trudged back and parked it out of the way.

Once outside, of course, the uniform made its wearer stand out rather than blend in. It would be conspicuous to hail a cab or get on a bus. Bad planning, not to carry along Daniel's clothes.

It would take about twenty minutes to "grow" inconspicuous clothes, and discard the janitor's. Too long. Taking a chance, it ducked into a souvenir shop and bought fairly modest tourist clothes—Hawaiian shirt, Bermuda shorts, and flip-flops. It changed in the men's room—also changing its skin to pale white—and carried the uniform out in the shop's paper bags.

In the line at the cab stand, it started mapping out its strategy. It told the cab to take it to the downtown Hilton, but paid attention for the last mile, looking for a more seedy place. The Crossed Palms looked suitably run-down.

It paid off the cab with an unremarkable tip, and walked straight through the Hilton lobby. On the way back to the Crossed Palms, it threw the janitor's uniform into a dumpster.

The chain-smoking woman at the desk was glad to give "James Baker" a room for three days, paid in advance with cash, no ID or luggage.

The room was musty and dark, and definitely not worth $150 a night. But the changeling was finally able to relax, for the first time since the side door to the Wing Room had opened to admit the unwelcome spies.

This couldn't be rushed, it told itself; the identity it took back to Apia had to be absolutely bulletproof. It could go back to California and re-create its college-boy surfer dude, but why not just stay in Hawaii? Closer to Samoa, and so a more likely point of origin for a job-seeker.

There would be a job opening soon. Michelle, the project's receptionist, was seven months pregnant. She was looking forward to quitting and becoming a full-time mother.

The changeling had perhaps a month to construct a perfect replacement and establish her in Samoa.

Receptionist would be good. It didn't dare try lab technician again, but it did want to be someone Russ would notice, and fall for.

It had evidently been caught because it had masqueraded as a real person, and was snagged by some routine security procedure. "We talked to the real Rae Archer" was all the changeling knew or needed to know. Using an actual human had been lazy. This time it would create a woman from the ground up.

The changeling knew pretty exactly what Russ liked in a woman. But it probably wouldn't be too smart to make a woman perfectly built to order—even if it didn't make Russ suspicious, someone else might notice.

So she wouldn't be a modest slender Oriental woman with a degree in astronomy. A normally plump blond Caucasian who had studied marine biology. It would be smart if her first impression (especially to Jan, but also to Russ) was not too sexy. She could work on Russ slowly, in time-honored ways.

It bothered her to be sneaky with him. She loved him more than she had any other man or woman on Earth. But she had to find a way to the artifact, either through trust or stealth, and Russ was the obvious candidate for either.

The changeling wanted to be about thirty years old, married once briefly and widowed, no children, no ties. It had to be in complete control of the woman's fictional paper trail, starting with birth.

It took most of a beautiful morning, walking through Kalaepohaku Cemetery, before the changeling found the perfect burial plot: Sharon Valida, born in 1988, died in '91. Her parents were buried beside her, both dead in 2010.

A short computer search in the library showed her parents had died together in

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an auto accident. Sharon, just to complicate things, had been born in Maui, and died there. She was cremated and her ashes brought back here. But her death certificate was presumably in Maui, and had to be pulled from the system there.

Best to do things in proper order. The changeling flew over to Maui, still the pasty-faced tourist guy, and easily found the office where birth and death records were kept.

It spent a night in a closet, listening, making sure the place would be empty the next night. There was one complication: although there was no night watchman, there were video cameras covering every hall.

The changeling didn't like to take the form of objects rather than living things; it was difficult and painful and time-consuming. But there didn't seem to be any alternative in this case.

It became a sheet of grimy linoleum. The floors of every hall were the same dirt-colored plastic. So it was able to slide out through the millimeter clearance between door and floor and slowly undulate down the hall to Vital Statistics. There were no cameras in the office, so it rolled up into a cylinder and turned into a sort of cartoon human for convenience, or at least a roll of linoleum with feet and two two-fingered hands, keeping the drab linoleum color and texture.

The file drawers weren't locked, so it was easy to pull the paper death certificate. The electronic record was another matter. Even if it knew which machine to use, there would be passwords and protocols. It would have to solve that problem from outside the system, as Sharon Valida.

It found Sharon's birth certificate, and memorized the handprint and footprint on it. No retinal scans in 1990.

It gave itself a 2007 driver's license, still no retinal scan. It had to take a chance on the Social Security Number, changing a few digits from one that belonged to a person born in Maui the same year as Sharon.

Her parents' drivers licenses were still on file, with pictures; they'd lived in Maui until 2009, the year before they died. Her mother had been a strikingly beautiful blonde, which was convenient. The changeling generated a teenaged version for Sharon, with a 2007 hairstyle, nothing extreme. No facial tattoo or ritual scars. For "SCARS OR IDENTIFYING MARKS," it gave Sharon a small hummingbird tattoo on the left breast.

Russell would like that. Dipping into the nipple.

It found a map with school districts, but of course they'd have been much different in 2007. Guessing would be dangerous; some damned computer was liable to do a routine systems check and flag an anomaly. It took a little searching, but there was a file called HS District Archives; it found the one closest to her parents' address and enrolled her.

It gave her a science track with APS; she aced all her science and math but didn't do too well in humanities and arts. She also aced business and keyboard, which might count for more than her college degree. That would be the next day's work.

Checking against other students' yearbook entries, it gave her Chess Club and volleyball. Religious preference, none. Then it worked back through middle school and grade school records, which were mostly routine stuff. Her fourth-grade teacher noted that she did her work "with ease and dispatch," a compliment she had given to about half the class.

It was not quite dawn when the changeling turned back into linear linoleum and slid down a corridor to a location that wasn't covered by the cameras, a stairwell that led to a musty basement. It took its janitor form, remembered from Berkeley, and waited until ten to walk upstairs and pass through the crowd, out onto the street.

It turned back into the tourist in a

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public library restroom stall, and used the library computer system to outline Sharon Valida's academic career at the University of Hawaii, a more reasonable destination for an ambitious girl than the community college on Maui. She would study business with a concentration in oceanography—in fact, she would take Elementary Oceanography from herself, as the charismatic professor Jimmy Coleridge. The changeling used its intimate knowledge of the university's academic and bureaucratic structure to give Sharon a respectable-but-not-brilliant four years of study. Inserting the paper and computer records verifying her existence there would be even easier than the past night's work in Maui.

(The changeling had not just dropped everything when it changed from Professor Coleridge into Rae Archer. The timing had been perfect; the *Sky and Telescope* ad appearing right at the end of the term. So the professor turned in his grades and told everyone he was taking the summer off for a diving vacation in Polynesia, which was not completely a lie.)

There was one thing left to do before going back to Honolulu. The changeling went to a mall and bought a recent wardrobe for Sharon, and then went back to the Crossed Palms and spent a painful half-hour changing into her. She rented another room for the night and went back to the Vital Statistics office at 4:30, a half-hour before closing.

"May I help you?" The woman at the window, about forty, had a bright fixed stare as if she'd been caffeine-loading to stay awake till five, and seemed less than sincere in her desire to help.

"I can't find my birth certificate," the changeling said. "I need a certified copy to get a passport."

"Photo ID," the woman said, and the changeling handed over the fresh, though worn, driver's license.

The woman sat down at a console and typed in Valida's name. She stared at the screen, cleared it, and typed it in again. "This says you died in '91."

"What, *died*?"

"Three years old." She looked up suspiciously.

"Well, duh. I didn't."

"Wait here a moment." She hustled off in the direction of the room where the changeling had spent the night.

She came back shaking her head. "Computer error," she said, and deleted the record with a couple of strokes. Wordlessly, she made a copy of the birth certificate and notarized it. She went down the hall to have another clerk witness it. The changeling walked out with its new existence certified.

In a way, it was simpler for Sharon to get a college degree than it had been to go through grades 1 - 12, since the changeling could work from inside. It changed its retinal pattern to match that of Professor Jimmy Coleridge, to get into his front door, and took a cab from the Honolulu airport to his apartment off the Manoa campus.

The changeling didn't think anyone saw Sharon entering the apartment, but if they did, it wouldn't be that uncommon a sight.

The next morning, it took a half-hour to change back into Jimmy, who fortunately didn't weigh much more than Sharon. It put on teaching clothes and walked over to Coleridge's office at the School of Ocean & Earth Science & Technology.

The departmental secretary was surprised to see him. "Back from Samoa already? I thought you were gone till August!"

"Just for a couple of days. I've got an open ticket on Polynesian Airways. Thought I'd catch up on some stuff and get a few decent meals."

"What do they eat in Samoa? Each other?"

"Just for variety. Usually McDonald's."

"What about the space alien? Were you there?"

"Yeah—they think it's some Holly-

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wood stunt."

"I hope they're wrong. That would be so maze."

"Would be." There was a double handful of mail waiting. The changeling took it to Coleridge's office, dumped it in a drawer, and held the desk's identifier cable up to his eye. The console pinged to life and it started typing.

It wanted to give Sharon a Bachelor's of Business Administration, with a minor in Oceanography. It only took twenty minutes to map out her course of study, and then another hour to verify which courses had been offered in which year.

The oceanography minor was easy—she even took OCN 320, Aquatic Pollution, from Professor Coleridge himself, and got an A. The business major was harder. It had taken some business courses as protective coloration in 1992 and 1993, while it was being a California surfer, but things had changed a lot in the past thirty years. Majors had to have calculus and advanced statistics.

It wouldn't be smart to try to generate actual class records; nothing on computer. But it could fake a paper copy of her transcript, and sneak it into the proper file at Business Administration, which was also at the Manoa Campus. It was unlikely that anyone would ask for her transcript, but if they did, maybe the scam with the birth certificate could work again.

The changeling gave itself, as Sharon, glowing job references from two dead professors and Coleridge, who of course was off diving but could be reached at jimmyc@uhw.edu.

41. Apia, Samoa—16 July 2021

"She wasn't human," Jack Halliburton said. "No human could have an arm blown off and then out-do a Hollywood stunt man in falling, running, swimming. What was she?"

Jack and Jan had Russell alone in Jack's suite at Aggie Grey's. "You loved her?" Jan said.

"This is so confusing," Russell said.

"You had sex with her," Jack said.

"Jesus, Jack." Russell winced and turned away.

"No, listen. You've had sex with other women; lots of them."

Russell looked toward Jan for support and got a blank stare. "I wouldn't say 'lots.'"

"So was there anything about her anatomy that seemed strange? Anything about her psychology?"

"I did love her," he said to Jan. "I fell for her like dropping off a cliff."

"But *think*!" Jack persisted. "Anything that wasn't human?"

"She was a hell of a lot more human than *you*, Jack. She was funny and sweet and interested in everything."

"That's scary," Jan said.

"I know it is." Russell sank back into the big soft easy chair. "More scary to me than anybody."

Jack levered himself up off the couch and stalked across the room to a table with crystal liquor decanters. He poured himself an inch of whisky and dropped an ice cube into it. "Do you think she could have been some kind of construct, sent to spy on us?"

"Yeah, sure," Russell said. "A robot. That accounts for the metallic sound when you rapped your knuckles on her."

"I mean biological."

"Of course. You think anybody in the world is capable of 'constructing' a superhuman?"

"She came from somewhere." The phone rang and Jack snatched it up. He listened for about a minute, giving monosyllabic responses, and then said, "I don't know what to say. We'll get back to you. Thanks." He set the phone softly back on the cradle.

"Who was that?" Jan said.

He twirled the ice around in his glass. "Woman named Peterson, Doctor Peterson. Forensic pathologist. Local." He shook his head. "They sent a flesh sample from the arm over to Pago Pago for

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analysis, DNA identification."

"They identified her?"

"It's not a 'her.'" He took a small sip. "It's not even human—not even animal. It doesn't have DNA."

"Holy Christ," Russell said.

Jack sat down. "Russ . . . you were fucking an alien from another planet. That's probably illegal in Samoa."

42. Honolulu—18 July 2021

The changeling had winced when it saw the headline SPACE ALIEN DISCOVERED IN SAMOA. It bought a paper and learned that it had murdered a "high-level American intelligence operative" by "injecting a mysterious substance."

An editorial urged tolerance rather than fear. The alien would come forward if it knew it would not be harmed. The American government could be reasonable.

That was tempting. The electric chair would be a stimulating experience.

The story explained that scientists knew it was an alien because a tissue sample had no DNA. Was there any way to fake that?

The changeling had several degrees in biology, but didn't know much about its own. It didn't know what mechanisms were involved in changing from one creature—one *thing*—to another. It was as natural as breathing or photosynthesis were to organisms on Earth, and no more amenable to auto-analysis: if you were the only creature around that breathed, you could hardly dissect yourself and learn about lungs.

Of course the changeling *could* dissect itself, and did on a regular basis, but that didn't teach it anything on the molecular level. Besides, the only science it knew was human science, and whatever it did when it changed into a shark or a roll of linoleum wasn't covered by Organic Chemistry 101.

It did absorb DNA when it ate, naturally, and human DNA sometimes when it had sex with a male human. But whatever passed for metabolism in its body didn't retain the stuff. It could absorb a school of albacore tuna and somehow change their substance into a Volkswagen.

Poseidon was probably going to be on the lookout for their alien returning, and would test job applicants for the presence of human DNA. What procedure could Sharon Valida expect?

A little research showed it that DNA testing for purposes of identification was usually done with buccal swabs, just wiping a few cells off the inside of the cheek, noninvasive and less personal than a blood or sperm sample. All it had to do was contrive to have a mouthful of human flesh before it sat down to apply for work.

Biting somebody, alive or dead, on the way to an interview didn't seem practical. You could buy live portable DNA in the form of blood or sperm, but both posed practical problems, when it came to opening one's mouth for the doctor or police officer.

Pure DNA was sold for research purposes, but only in microscopic quantities, hardly a mouthful. Besides, they might even decide to *be* invasive—want a job? We'll have to take a little blood.

If it were only Russell involved, the changeling would just come out and tell him. Show up one night as Rae to get his attention, and explain. But there were all those tiresome people with guns—and Jack was ultimately in charge, not Russell. Jack felt dangerous, almost feral in his greedy intensity, and he could infer the changeling's abilities from what had happened at Aggie Grey's. There probably wouldn't be a window facing the sea if Jack had anything to do with the conditions of their meeting.

On the other hand, the changeling knew enough about the Poseidon labs to know they couldn't test for DNA in-house. The samples would go to Pago Pago, or even back here to Honolulu. That would buy some time, and also might afford an opportunity for substitution.

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Perhaps the smartest thing would be to wait, to go join the circus again for a couple of decades; let things cool down. Jack and Russell would die, and new people would be in charge of the artifact.

But there were factors arguing against that, not the least of which being its feelings for Russ; it wanted him, above all others, to know what was really going on. Also, in twenty years—or five, or one—it was likely that the artifact would wind up in a vault in Washington, or Langley, impossible to approach.

There was something deeper, too, that the changeling couldn't quite put a name to. Something in that pattern of ones and zeros was coming together—not logic, not numbers, but some sort of message.

Pam and Russ and the rest of Poseidon were analyzing the digits by looking for an analogue to the Drake message. But maybe the message was not for them. Maybe it was not for any human.

43. Apia, Samoa—20 July 2021

They decided to set a trap for the alien.

"Rae wanted to get to the artifact, but was playing it cool. She asked me about getting around the security protocols so she could actually be in the same room with it; touch it." Russell was doodling while he talked, drawing precise geometrical figures. He and Jack and Jan were outside Jack's suite at Aggie Grey's, talking quietly on the balcony. Jack had belatedly realized the spooks could have had his room bugged. It was less likely with the wrought-iron patio furniture, exposed to the elements.

"You told her you could arrange it?" Jan said.

"Put her off. I said security'd probably be relaxed soon, if the artifact stayed calm."

"Leading her on," Jack said.

"Maybe so. But I had no reason to think it was anything other than normal curiosity. Who wouldn't want to go take a look at the thing?"

"Especially someone who'd come all this way to take a low-paying job, out of curiosity about it," Jan said. "We tested her enthusiasm, remember, by having her pay her own way out for the interview."

"Which we can do again, for the trap," Jack said. "But maybe we should be more subtle."

Russell nodded. "Whatever Rae is, she knows human nature well. She's either going to be very careful or direct. She might just phone us and set up a meeting, one where she can control the conditions."

"I wonder how old she is," Jack said.

"Thirty-some."

"Try thirty thousand. She can't be killed—at least not by a point-blank shotgun blast, or by drowning—and she can masquerade as another person down to the fingerprints and retinas. Who was she before Rae Archer? Before that? She might go all the way back through human history and prehistory.

"She might have come to this planet even before humans evolved. Wandering around as a sabre-toothed tiger. As a dinosaur before that."

"No," Jan said, "I don't think she's an alien at all. Just a different kind of human. They probably evolved alongside us and learned to keep their nature secret—or somewhat secret. There are legends about shape-changers and immortals."

Jack rubbed his beard. "If so, there can't be many of them. They'd just take over."

"Maybe they have," Russ said. "We ought to check every world leader for DNA." He and Jan laughed nervously.

"The CIA is probably having this same conversation," Jack said.

In fact, by the time Jack said this, every employee of the CIA had donated a few cheek cells to the agency, as had employees of NSA and Homeland Security. A "suggestion" had come down

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from the White House that all of the country's leaders be tested.

Laboratories that do DNA testing were initially overwhelmed, but then their usual work was not just testing for the presence of DNA, but rather analyzing a sample to link it to a particular microorganism or person. This called for time-consuming processes like electrophoresis or mass spectrometry. But of course in those cases they already *knew* that a sample contained DNA; the question was pinning down its origin.

It turned out that a DNA/no DNA test was a lot simpler. You take the buccal swab and swirl it around in a test tube containing a solution that turns acid in the presence of even a microgram of DNA, then add a drop of Phenol Red. If it turns yellow, voila, the scraping was from a human cheek, or at least came from something that had DNA of some description. It couldn't discriminate between onion DNA and human, but in this case it didn't matter. Samples of the "flesh" and "blood" in the arm that resided in a freezer in the Apia police station had been sent all over the world for analysis. The samples had the right proportion of carbon, hydrogen, oxygen, phosphorus, sulfur, and nitrogen to have come from the amino acids that make up human (or animal) protein, but their chemistry was not human. It was not even organic chemistry.

The thing it came from had not been alive, in the sense that a human is alive.

The tests proved that every member of the American intelligence community was human, at least in a nominal sense, and so were all prominent politicians, including the president, which surprised a few people.

44. Apia, Samoa—22 July 2021

Just a week after it had been blasted with a shotgun and swam to the airport, the changeling returned. Sharon Valida had a brand-new passport, a six-month work permit, and a suitcase full of light business outfits. Over the internet, she'd landed a job with a bank in Apia looking for a customer representative who could speak German and French.

She also had packed a nice bikini and cute jogging outfit; a dinner dress and a bottle of Sudafed unlike any other in the world. Each capsule had been carefully opened and emptied and refilled with a couple of hundred dollars' worth of reference DNA stolen from a teaching laboratory at the University of Hawaii. She had bitten down on one every few hours from the Honolulu airport to the Apia one, where a uniformed man apologetically stuck a swab in her mouth and stroked the inside of both cheeks. He did something under the counter and then waved her through.

The changeling was in a quiet race against time. It had to establish a convincing identity as a working woman in Apia before Michelle Watson, the Poseidon receptionist, retired to have her baby. It knew that Michelle's husband was a pleasant but unemployed beach bum, and she wanted to work as long as she could waddle down to the bank with her paycheck, which was okay with Poseidon.

Some time in the next six weeks they would advertise for a replacement. The ad wouldn't ask for a pretty young woman with a degree in business and minor in oceanography, but that's what they'd get.

The changeling rented an apartment on Beach Street, a few blocks from the project, and began a routine that included jogging at dawn and dusk, which was when Russell was out riding his bike. He said he used the time to think, but he probably wouldn't be thinking so hard he would ignore a pretty blonde in a tight silver jogging outfit with PROPERTY OF NOBODY stenciled on the back.

Its bank job was not difficult, and was moderately interesting when they actually needed Sharon as a translator. The rest of the time they had it out front, being pretty and a teller, both of which the changeling could do without thinking

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about anything but ones and zeros.

Three of the men at the bank asked Sharon out, and she dated them in strict rotation, without becoming "involved." It had been a woman often enough to know that men would accept a lack of sexual activity for a long time, if you were attractive and kept them talking about themselves. They were British, American, and Samoan; reserved, brash, and shy, respectively. The Samoan was the most interesting, taking his *palagi* woman to native places where no one else was Caucasian, and doing physical things like sailing and swimming. More traditional physical behavior, she was reserving for Russell.

Russell pedaled by her almost every morning, either approaching with a conventional I'm-not-looking-at-your-breasts smile and nod, or slowing down and coasting as he closed on her from behind.

The changeling contrived an incident the second week. Hearing the familiar bicycle about a block away, it stumbled and fell, skinning a knee.

Russell raced up and dropped his bike with a clatter. Sharon was looking at the minor wound and tentatively picking gravel out of it. The changeling manufactured enough histamine to make itself on the verge of tears.

"Are you all right?" He was a little out of breath.

"It's nothing," the changeling said. "I'm such a klutz."

"Wait." Russell stepped back to his bicycle and got the water bottle. He unscrewed the top and, steadying her with a light touch to the calf, poured cool water on the abrasion.

"Ooh." There was no pain, actually, but the changeling made itself flinch. "No, it's all right."

It was more than all right, actually. His familiar touch and the smell of his sweat. If the changeling had been slightly more human, she would have grabbed him and held him tight.

"We have a first-aid kit back at the office" he said, nodding in the direction of the project, about a block ahead. "We ought to clean that and wrap it up. Wounds get infected so fast here."

"Thank you, I . . . I don't want to be any trouble . . ."

"Nonsense." He gave her an arm and helped her up. The changeling shivered slightly at his touch on its waist.

It limped a little, hand on his shoulder for support. "Your bike?"

"Nobody'll take it. It's a junker; I don't even carry a lock."

"People are different here, aren't they? Back home, someone would steal it whether it was worth anything or not."

"Where's home?"

"Honolulu, Maui originally."

He nodded. "You're not a tourist, are you? I've seen you around."

"Work at a bank downtown, translator."

"You speak Samoan?"

"No." She shook her head and brushed away her hair in a graceful gesture that was not Rae's. "French and German, some Japanese. I'm studying Samoan, but it's hard."

"Don't I know. I've been here two years and can't even say 'pass the disgusting vegetables'."

"*Aumai sau fuala'au fai mea'ai ma*," the changeling said. "I haven't learned 'disgusting' yet." It hadn't given Samoan a thought since starting on the ones and zeros, actually, but remembered some from the first few days of that incarnation.

"Pretty impressive, actually. Languages come easy to you?"

Job interview? "They did when I was younger. I learned Japanese and some Mandarin."

"Hawaiian, of course?"

"No," it said quickly, remembering that Jack did speak some. "Funny thing, you don't really need it socially, and no one expects someone who looks like me to speak it." It shrugged. "Probably a class or race element, too. My mother

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and father wouldn't have been thrilled."

"Know what you mean." He waved at the guard in his little kiosk and unlocked the door to the main building. "We lived in California, and my dad wasn't happy about my taking Spanish. Even though it was the most useful second language." The changeling knew that, of course.

They went into the familiar reception room. He sat the changeling down in Michelle's chair, the one it hoped to be occupying soon, and began opening and closing drawers. "First aid kit, first aid kit." He pulled out a white plastic box. "Ah."

The changeling had a sudden thought. "Would you mind . . . I feel a little faint. Could I get something to drink?"

"Sure. Coke?"

"Fine." She unzipped the little wallet on her wrist.

He waved a hand. "Free with my card." It knew that, and knew the machine was out of sight down the corridor.

When he turned the corner, it slowly spun the chair around ninety degrees, so its back was to the camera behind Michelle's desk, and plucked a Sudafed capsule from the wallet. Broke it between thumb and forefinger and sprinkled DNA into the wound. It got some on the fingers of both hands, too, slipped the empty capsule back into the wallet, and returned to its original position before Russell got back, feeling a little silly for being so thorough. But Russ wouldn't be Russ if he hadn't thought it through enough to suspect any new woman who came into his life.

"Thanks." It took the Coke and drank an appropriate amount, and looked around. "So this is the place."

He pressed an antiseptic pad against the knee. "This is the place, all right. Welcome to the madhouse."

"Mad island," it said. "Creature from outer space and its UFO."

He shook his head and tossed the pad into Michelle's trash can. "There are other explanations. But they're no less bizarre." He shook a can of bandage spray—"Cold."—and sprayed the knee liberally.

"What explanation do you like?"

"It's as good as any." He tapped the knee around the wound, checking the spray. "What do the people at the bank think?"

"Most of them are UFO. One guy's convinced it's all a movie gimmick, and you'll all look like fools when they reveal it."

He stood up. "I'd take bets against that. I talked to the movie people. They're exploiting it for all they're worth, but they were obviously as surprised as anyone else."

"That's what I told him. They would've had someone around who happened to have a camera. Else why spend the money?"

"Yeah, no-brainer. Can you flex the knee okay?"

It swung her foot carefully. "I think it's fine." She took his arm and stood up. "Thanks."

"Are you doing anything for lunch?" He laughed nervously and kneaded his brow.

"I'm tied up today," the changeling said, not to appear too eager. "Tomorrow's free." Putting out her hand: "Sharon Valida."

"Russell Sutton. Noon at the Rainforest?"

"I'd be delighted." It smiled at him, wondering if her dimples were too cute. "My knight in shining armor."

"Bicyclist with a water bottle." He escorted her out. "'Bye." He watched her jog away, slightly favoring the injured knee, and then walked back to retrieve his bike.

Could it be, he wondered. She didn't look anything like Rae, but the assumption was that she could look like anyone.

He leaned the bike up next to the entrance and went back inside. In the bio corner of the lab he got a latex glove

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and a plastic bag. Back at the reception desk, he picked the bloodstained pad out of the trash can put it into the bag. He emptied the Coke can out in the men's room and put it in the bag, too, gingerly holding it by the rim, and printed SHARON VALIDA on the bag with a Magic Marker.

Trying to out-think an alien intelligence, they'd figured that one obvious avenue back to the artifact was Russell's weakness for pretty women—for women in general, actually. If Sharon had been a small attractive Asian, he would be more suspicious.

One part of him wanted the samples to have no DNA, so they could close the trap. A smaller part hoped she was just a sexy blonde with a sense of humor and a non-alien intelligence.

He put the bag on the bio desk with a short note to Naomi. Then he went back to the bike and checked the cyclometer. Only four miles; one more to go.

He pedaled off in the direction Sharon had gone, but didn't see her. Went home to shower before work, perhaps, or maybe to check the oil in her *other* flying saucer.

Russell was lost in reverie, staring at the monitor without seeing it, and was startled when Naomi set the bag down next to him, with a clink of Coke can.

"Your Sharon has plenty of DNA, I'm afraid. Next move is up to you."

"What? Oh, lunch."

"Hope she tastes good," Naomi said with a lecherous wink. Russell balled up a piece of paper and threw it at her.

Back to the secret message. He was putting together a one-page website that only Rae would completely understand. It was called "A Rae in the Darkness" and was headed with three photos—Russell and Rae flanking a snap of Stevenson's gravestone verse he'd taken the hour before she'd led him down the hill to the hotel.

He'd skimmed through a book of Stevenson's poetry, and didn't like much of it, but this one quatrain was not far off, and he typed it in:

LOVE, WHAT IS LOVE?

LOVE—WHAT IS LOVE?
A GREAT AND ACHING HEART;
WRUNG HANDS; AND SILENCE;
AND A LONG DESPAIR.
LIFE—WHAT IS LIFE?
UPON A MOORLAND BARE
TO SEE LOVE COMING AND
SEE LOVE DEPART.
—ROBERT LOUIS STEVENSON

Then he pasted in thirty characters of the artifact's message:

11010010110100101110100100101 1

And then his own message:

RAE, WHEN I DID SEE YOU DEPART, LITERALLY, I DIDN'T KNOW IT WAS YOU, AND IT DEEPENED THE MYSTERY.

IF YOU HAVE TO DISAPPEAR, THAT'S YOUR DECISION. BUT YOU KNOW THAT IF THERE'S ANYONE ON THIS WORLD YOU CAN TRUST, IT'S ME.

I KNOW I DON'T KNOW YOU, BUT I LOVE YOU. COME BACK IN WHATEVER GUISE.

—RUSS

There was a box for "affinities," words that would draw a searcher, or surfer, to the site. He typed in Poseidon, Apia, artifact, alien, and so forth, ending with "Rae Archer" and "Russell Sutton." He knew that the first people drawn to the site would probably be the CIA and their ilk, but there was no way to get around that. He assumed that Rae would be canny enough to anticipate them, too.

The Rainforest Cafe was nostalgic '90s funk in a jungle setting. Bamboo and palms and elephant ears under blue lights and mist nozzles, quaintly angry rap whispering in the background.

Russell felt a little underdressed in cutoffs and an island shirt. It was the weekend, but Sharon had come from work, wearing suit and tie. She loosened the tie and patted her brow with a tissue,

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prettily.

"I should have suggested an air-conditioned place."

"Glad you didn't. I was freezing in the office." She shrugged out of her jacket.

"You've always lived in the tropics?"

"In the heat, anyhow. You?"

"As soon as I could choose." Russell told her about growing up in the Dakotas. He'd gone to college in Florida, and never had to live through another winter. "Most of my experience with being cold now is underwater, working in a wetsuit."

"Been there." She covered her mouth, laughing. "When you don't have enough pee to warm it up."

He poured her some iced tea. "You dive a lot?"

"When I was in school, a little. Now I mostly snorkel. A guy at work took me out to the reef at Palolo last week—all those giant clams, I couldn't believe my eyes!"

"They're something." He served himself. "Was it your major, marine science?"

"No, I did Business Administration. Minor in oceanography—that was my real cold-water experience. A summer course diving in the Peru current." She'd actually been there as professor, not student, but the university records would confirm she'd taken the course and made an A.

"We used to be out there," he said. "My company, Poseidon. We did marine engineering out of Baja California."

"Until you found the alien thingie."

"Well, we didn't know what it was, at the time." He broke open a roll and buttered one half carefully with healthy spread. "We pinged it with sonar and registered it for later salvage. It was a while before we actually went down and took a look." He gestured down the road with the roll. "Then this happened."

"It must be exciting."

"Exciting and frustrating in about equal measures. We're not getting anywhere." He drew a shape on the tablecloth with his fingernail. "What do *you* do for excitement? Or frustration."

"I don't know. Come out here, run, fall down." They laughed. "I've been kind of drifting. Both my parents died when I was in college, like ten years ago, eleven."

"I'm sorry . . ."

She dipped her head. "Yeah. They left me some money, and I sort of wandered around Europe, then Japan. Now that the money's gone, I wish I'd stayed in school. Not much you can do with a B.B.A."

"You're still young. You could go back."

"I guess thirty-one's young." She stared into her tea. "Maybe not to graduate school admission committees."

"You'd go back to business?"

She shook her head. "Maybe macroeconomics. Pacific Rim economics. But I've been thinking more oceanography. I could get a B.S. in a year, maybe three semesters." She smiled. "Come out here and work for you."

"Not with a bachelor's," he said seriously. "Take a couple of years and get a doctorate. The artifact's not going anywhere."

"But you don't know that," she said. "It might decide to go back to Alpha Centauri."

Their sandwiches came. Russell discarded the top piece of bread and carefully sliced the remainder into one-inch strips, then rotated the plate ninety degrees and cut the strips into thirds. The changeling remembered the habit and smiled.

"Saves me a hundred calories," he said. "The media all think the thing's from another star. That's the easiest explanation. We're trying to come up with something less obvious."

"Like what? Secret government project?"

"Or that it's always been here. You know what hell this has been for physicists and chemists."

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"I can imagine."

He took a bite and then salted everything, as the changeling expected. "*That's* no different whether the thing is local or from another galaxy. It means there are very basic laws we don't understand about . . . the nature of matter." He speared a square of sandwich and gestured with it. "It's chaos. Nothing we know is true anymore."

"Can you really say that?" the changeling said, carving its own sandwich into quarters. "Like we learned in school, Galileo's physics was an approximation of Newton's; Newton got swallowed by Einstein; then Einstein by Holling."

"Hawking, then Holling, to be technical. But this is different. It's like everything worked, down to eight decimal places, and then somebody says, 'Hold it. You forgot about magic.' That's what this damned thing is." He laughed. "I love it! But then I'm not a physicist."

"They must be going crazy." She picked up one quarter and nibbled on it.

"You should see my e-mail. Actually, *I* should see my e-mail. This indispensable woman, Michelle, throws out nine-tenths of it before I come to work."

"She knows physics?"

"Well, like you—she's an accountant with some course work in various sciences. But she reads everything, knows more about general science than I do."

"She doesn't really throw them away," the changeling asked. "You at least glance at them?"

"Oh, yeah. At least the ones that have some entertainment value—we call them the X-files. I get together with Jan, our space scientist, every Friday to run through them. Kind of fun, actually." He speared another square. "Pleasant nutlike flavor."

"Did you ever get anything useful?"

"Not yet." He turned serious. "The whole game is going to change soon. We're going public with . . . an aspect we've kept secret. Wish I could tell you."

The changeling was glad he couldn't. Knowing about the message gave it an edge for Michelle's job. Those credits in Math 471 and 472, advanced statistics. "Oh, come on. Pretty please?"

He smiled. "Your womanly wiles will get you nowhere. I'll tell you on Monday, though, if you'd like to have lunch again."

"Okay. Can I bring my pal from the *Weekly World News*?"

"He might already be down at the office. We're making the announcement at 9:00."

"You really think you'll be free for lunch, then?"

"I'm telling you too much." He looked left and right. "That's why we chose Monday. No planes till Tuesday morning. Gives us, what, some measure of spin control."

He did look a little worried. The changeling reached over and patted his hand. "Mum's the word."

"'Mum's the word'?" He chuckled. "I haven't heard that since I was a kid."

Oops. "My mother used to say it. Where does it come from?"

"Where do any of them?" He relaxed. "How are things at the bank working out?"

"They're nice enough people," it said, quickly. "No real challenge, though. A few times a day I haul out a language to calm down a customer. Walk him through a document or just help with numbers. The job description said 'international relations,' and I suppose that's technically true."

"Apia's smaller than you thought it would be?"

It shrugged. "I read up on it. No real surprises . . . except you guys. I expected a bigger deal."

"Well, it's only fifty people. We had a pretty low profile until a couple of weeks ago."

"Your space alien. That made the front page in Honolulu. You found her?" It closed its eyes and shook its head. "Sorry. Mustn't pry."

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"No; I wish we had. Love to spring that on the tabloids."

"You don't believe it's in a secret wing in the Air Force hospital in Pago Pago?"

"No, it's locked up in Roswell, New Mexico." He laughed. "Before your time." The changeling had been there twice, actually, as a juggling dwarf and an anthropology graduate student.

So Monday they were going to reveal the artifact's coded response—or at least the fact that it had responded. The changeling wondered how that would change its situation, and what it could do before then to help its chances for the job.

Russell offered a possibility. "You work tomorrow?"

"No, everybody goes to church. Except me."

"I'm off, too. You want to bike somewhere for a picnic?"

"God, I haven't ridden a bike since college. Give it a try, though. I guess I could rent one someplace."

"Oh, I have a spare." He scratched his chin. "I usually go out to Fatumes Pool or Fagaloa Bay on Sunday, but that's a little far if you're not used to it. We ought to just tool around, see some local sights, wind up at Palolo or the project for a picnic and a swim."

"Does the reef go over that far?"

"No, it's just a white-sand swimming beach. The local kids like it. We even set out a shark barrier last week."

"You get a lot of sharks?"

"Just takes one. A big hammerhead attacked a boat in the shallows—bit a hole in the hull!—and so the family, the *aiga* that technically owns the land the project's on, asked whether we'd cooperate in putting a barrier up to protect swimmers. Just a wide-mesh net"—he sketched a six-inch square with his fingers—"to keep out really big fish. We bought it and they provided the manpower."

An interesting challenge, the changeling thought. A hammerhead could pretend it was a dolphin and jump over it. "That sounds good. They have picnic tables and all?"

He nodded. "A grill. Let's be American—I know a place with fairly convincing hot dogs. I'll pick some up this afternoon and put them in the office fridge."

They made arrangements to meet at Aggie Grey's in the morning, bring a bathing suit, and she went back to her air-conditioned bank.

As he pedaled off toward the butcher shop, Russell thought about what he was getting into. He couldn't afford an actual girlfriend; he had to be "available" for the Rae-alien's return. That was one element of their plans to trap the creature, because when it returned it was likely to repeat the previous strategy, and try to seduce Russell. Or maybe Jack or Jan. Anybody new who came into their lives would have to pass the DNA test.

He toyed with the idea of arguing to the others that maybe the alien had figured out a way to manufacture DNA, so he should continue to pursue Sharon even though she'd passed the test—all in the name of science, of course.

45. Apia, Samoa—July 2021

Russell knew he wasn't the only one in passionate pursuit of the alien. But he didn't know that his competition was more formidable than the CIA agents who were just now becoming interested in Sharon.

The chameleon had been in and out of Apia ever since it was obvious they had a vehicle from another planet. If there was anybody else like him on Earth, he would be drawn here, too.

The changeling also had spent much of its human life looking for another changeling. It saw the meeting as a kind of reunion—"together again for the first time." They could sit down and talk, and perhaps together solve the mystery of their origin.

The chameleon, on the other hand, was not interested in mysteries. He was interested in eliminating competition.

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He wasn't stupid. Over the millennia he had often attained his culture's highest degree of education. He knew that his desire to destroy the competition was not rational. But it was programmed into every cell of his body; it was what he had instead of the urge to reproduce. And sexual desire was a pale flame beside his passion to destroy, to protect himself.

On his own terms it was easy to rationalize: if the creature was like him, their first meeting would be short and brutal. Best strike first. No human could kill him, but no human knew how profoundly damaged he would have to be in order to actually die.

He did know and had to presume his competitor would as well.

46. Apia, Samoa—24 July 2021

The changeling regretted the impulse that had made it say it hadn't ridden a bike in years. It had been riding since before Russell was born, and simulating clumsiness on a single-speed Schwinn was an Oscar-level performance.

"How you doing up there?" She was leading them up Logan Road, not too hilly and no traffic, Sunday morning.

"I'm getting the hang of it." She stood up to crest the hills, and felt the gentle pressure of eyetracks on her butt. Maybe it shouldn't have worn the form-fitting jogging outfit, which got some disapproving stares from people on their way to church. But it certainly kept Russell's attention.

"All downhill from here. Just keep bearing to your left."

"Yeah, I've run this way. The project's down after the second light, V-something Road."

"Vaiala-vini. We'll make you a Samoan yet."

"As long as I don't have to like breadfruit."

"Fuata. We'll start out with hot dogs and move our way down the food chain. After turkey tails and mutton flaps, you'll be begging for fuata."

"Oh, I've got a freezer full of turkey tails. Deep-fried, you can't beat 'em." They laughed together, but there was an edge to it. They both knew the Samoan diet had been transformed by Western intrusion, all for the worse. Turkey tails and Big Macs, mutton flaps and corned beef—there weren't many natives over thirty who were lean and heart-healthy.

Russell waved at the guard as they went through the project gate. They dropped the bikes, no locks, in front of the main building, and raided his office fridge for hot dogs and beer, and put them in a foam cooler. He found charcoal in a utility locker and went out to start the fire while Sharon changed.

She studied her body in the ladies room mirror and made a few minor adjustments here and there. She knew she had Russell hooked. The question was whether to reel him in. It might be better to play a waiting game, and let Michelle get closer to delivery.

Or maybe force the issue. Get Russ in bed, and see what comes up.

It was a nice bright red thong bikini. The changeling pulled out a few pinches of excess pubic hair and ate them. It arranged the top so it just showed the wing tips of the hummingbird tattoo. It slightly deepened its lumbar dimples, a feature she remembered Russell noticing in her Rae incarnation.

It closed in for the kill, first wrapping a lava-lava around its waist. It could wear the revealing suit as long as at least its toes were in the water, but Samoans weren't happy about insensitive tourists flaunting their charms on the way there.

Russell was wearing the same blue-jean cut-offs he'd bicycled in, changing it into a swimsuit by taking off his shirt and shoes. The changeling smiled at his familiar body, a little pudgy in spite of athletic legs and arms, skin almost milk white—he never went out into the sun without total sunblock; both his parents had had skin cancer. His body hair was a silky down of black and white mixed, no gray, and his only tattoo, not visible

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now, was a small DO NOT OPEN TILL CHRISTMAS tag attached to a big scar he'd gotten from an emergency appendectomy by a village doctor in the Cook Islands. How many other women had giggled at that the first time he undressed in front of them?

He noticed her own tattoo immediately. "Bird?"

"Hummingbird." She pulled the top of her bra down almost to the aureole. Her breasts were small, which he liked.

"Very nice." He smiled and turned his attention back to the grill, splashing the charcoal with 100 percent isopropyl alcohol from a lab bottle. He snapped a sparker at it and it ignited with a blue puff.

"How much longer?" the changeling said. "I'm famished."

"At least twenty minutes." He gestured at the small cooler on the picnic table. "Beer? Or swim."

"Swim first. I'm all sticky." She turned her back toward him to step out of the lava-lava, which under other circumstances might have been a modest posture. She snatched her face mask, fins and mouthgill off the table and ran for the water. "Last one in has to cook the hot dogs." He stood and watched her run, with a growing smile. Then he jogged after her. She was already sitting in the shallows, only her head showing, when he splashed in.

"Oh well. I was going to cook them anyway."

She got the fins on, then spit into her mask and rubbed the saliva around. "Any reefs out here?"

"None close in. Some outside the shark net."

"Want to live dangerously?"

"Sure. I always wanted to see a 14-foot hammerhead up close."

I was only nine feet. "That's what bit the boat?"

"Not to worry. They harpooned it and shot it in shallow water. It attacked out of pain and confusion, most likely." He splashed water in his mask. "I've seen lots of sharks and never had a problem."

"Me, too. Maybe we never met a really hungry one."

"Maybe." He pointed. "There's some reef out that way. I'll hold up the net and you can swim under."

"Okay." They bit down on their mouthgills, and swam the hundred yards out to the net. They wriggled under it without any problem and proceeded out to the reef, the changeling naturally taking Russell's hand when it was offered. They swam in easy unison, moving fast with powerful surges from the fins.

The reef wasn't too impressive, compared to the dramatic one past the giant clam farm at Pálolo, but it did have lots of brightly colored fish and a small moray eel, watching their intrusion with its customary sour expression. Russell found an octopus the size of his hand, and they passed it back and forth until it tired of the game and shot away.

Russ pantomimed eating and Sharon nodded. They headed back to the net, with a short detour to chase after a medium-sized ray, hand in hand.

"That was nice," the changeling said, taking off her fins in knee-deep water, quite aware that when the suit was wet it left nothing to the imagination. "Especially the octopus."

"That was lucky. 'The soft intelligence,' someone called them."

"Jacques Cousteau." His eyebrows went up. "My oceanography prof had his old book."

As they waded ashore, Russell waved at a boy of six or seven who was sitting at their table with a bucket.

The bucket was half full of ice, with a large bowl of oka, the Samoan version of ceviche, fish marinated in lime juice and served with coconut cream and hot peppers. "Caught this morning, Dr. Russell."

He peered into the bowl. "Skipjack?"

He shrugged. "Ten tala."

"I don't have any money with me."

"I've got some." The boy was staring at her crotch, transfixed. She wrapped

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the lava-lava around her waist and pulled a few bills out of a pocket, and handed him a ten.

"Fa'afetai," he said, giving her the bowl and backing away shyly. "Thank."

"Afio mai," she said, and he turned and ran with the money.

They watched him go and Russell laughed quietly. "They're funny. Casual about nudity but conservative about clothing."

She nodded. "I'll never understand religion. Or fashion, for that matter." She set the bowl on the table and fished though the grocery bag for a couple of plastic forks. "Appetizer?"

"Thanks. Let me put on the dogs first." He smoothed the white pile of coals with a stick and got four hot dogs from the cooler.

The fish was cold and firm and spicy. "I could get used to this," the changeling said. "How long have you lived here?"

"Got here two years ago, when I came out with Jack Halliburton to set up the lab." He arranged the hot dogs in a precise row. "I commuted for a couple of months, finishing up old business in Baja. Pretty much stuck here since the lab was finished and the artifact was in place."

"You don't like it?"

"As a *place* it's okay. Vacation spot. Hard to do science here, though." He sat down next to her and speared a piece of oka. "Even with modern communications, virtual conference room and all, it's really isolated. You can break a fifty-cent part and be shut down for two days, waiting for the plane. And you miss . . . it sounds snobbish, it *is* snobbish, but I miss the company of like-minded people, people you don't work with—scientists, artists, whatever."

"I would have taken you for a loner."

"Well, I am, or was. The place in Baja was miles from nowhere, and that's one reason I leased it. But I could be in LA in an hour, and had an apartment just off the UCLA campus."

"Where you seduced college girls. I know your type."

He laughed and blushed. "Back when I had hair." He got up to check the dogs. "I do miss the college-town atmosphere. Bookstores, coffeeshops, bars. The libraries on campus. The girls on campus."

"It's a nice campus. I stayed there for two weeks, diving in summer school."

"Where?"

"A dorm." The changeling knew where Jimmy Coleridge's students stayed now. Where would it have been eleven years ago? "Maybe Conway? Conroy."

"Oh yeah. That's close to where I stay." He used tongs to rotate the hot dogs 180 degrees, then went to the cooler. "Beer? Or a glass of wine."

"You have wine in there?"

"No, back in the fridge. Only take a minute."

"That would be good. I'm not much of a beer drinker. Maybe when the dogs are done."

"Keep an eye on 'em." He jogged away.

The changeling considered its position. This was a cusp. If it began a love affair with Russ—or restarted one—it would probably kill its chances for the job. But the job was only a stepping stone to get close to the artifact. Maybe Russ's lover would have a better shot at that than the receptionist.

Why did it feel this drive to be in the physical presence of the thing? It had seen all the pictures, studied the data, read people's frustrated inconclusions.

It remembered the feeling when it swam from Bataan to California. The inchoate feeling, the hesitation, when it passed over the Tonga Trench.

It felt that now, more strongly than ever. Something was taking form.

Russell came back with two long-stemmed glasses of white wine, already misted with humidity. "Drink it while it's cold," he said, handing one to her, and drank off a third of his in a gulp. "Ready in a minute." He gave the hot

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dogs a quarter turn.

"So why didn't you just move the thing to Baja? Why start from scratch here?"

"I wish." He stared at the grill. "Partly the difficulty of moving the damned thing. Mostly political, though. Mexico's too close to the United States, not just in miles, but politically and economically. Jack didn't want Uncle Sam breathing down our neck. Mexican soldiers knocking on our door. *Down* our door."

"They could do that?"

"Sure they could. Threat to hemisphere security." He split two buns and set them on the grill. "Independent Samoa really *is* independent. And stable. Tonga was closer to the artifact's original position, but we didn't want to deal with the politics there.

"Jack studied surveys of the Samoan Islands, and wound up here by a process of elimination."

"The first factor being 'Is there a town?'"

He nodded. "They call it the only city in Samoa, but as you know, it's not exactly Hong Kong. It's really just a bunch of towns crowded together, but it does have a pharmacy, hardware store, and so forth." He gestured toward the main building. "And this patch of land: it was undeveloped, privately owned, and on the water. Jack got in touch with the matai of the family that owned it and arranged to lease it. He even became a Samoan citizen."

"Did he join the family, the aiga?"

"No, although he didn't rule out the possibility. Technically, he'd have to share all his wealth with the family." He raised an eyebrow. "That's not in his nature."

"You've known him a long time?"

"No. Not until . . . he got in touch with me about the artifact." The changeling knew, as Rae, that there was something secret going on there. Maybe it could tease the truth out of him in this incarnation.

"We never would have met, in the normal course of things. He was born into money, but chose a military career. I'm pretty far from either of those." He inspected the hot dogs. "These two are done." She held out paper plates and he installed buns and dogs on them, then repositioned the remaining two according to some arcane thermodynamic principle, and split two more buns to toast.

They silently went about the business of mustard and ketchup and relish, all out of small squeeze packets that Russell had liberated from various airports.

The changeling took a bite. "Good." Bland, actually.

Russell shrugged. "Sometimes I'd kill for some plain American sidewalk vendor food. Bacteria and all."

"You *made* money, though. As opposed to being born with it. You didn't raise the *Titanic* with spare change."

He shook his head, chewing. "Always use other people's money. Sometimes I feel more like a pitchman than an engineer." He paused to squirt another envelope of mustard into the bun. "Jack thinks, or claims to think, that there's a huge fortune in this. Maybe some day, but probably not for him. He's got a zillion eurobucks to earn back—and he's old."

"How about you?"

"I'm not so old."

"I mean money. Do you expect to make a fortune yourself?"

"No; hell, no. I'm in it for the game."

"That's what I thought. Hoped."

"Biggest thing in the twenty-first century. Maybe *the* biggest thing, all the way back." He stared at the containment building. "Even if it's not from another world. That would mean that our view of reality, our science, is wrong. Not just incomplete, but wrong."

"Isn't that true, no matter where it comes from?"

"In a way, no. Last century, a guy pointed out that a sufficiently advanced technology is indistinguishable from magic . . ."

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Arthur C. Clarke, the changeling didn't say. It had met him at an Apollo launch in the 1970's.

"And that gives us an out. Our science could still be a subset of theirs. Like going back to Newton and showing him a hologram."

He was so absorbed in his explanation he wasn't aware of the man walking quietly up behind him. His shadow fell over him and he jumped, startled. "Jack!"

"Sorry. Didn't mean to sneak up on you."

"This is Sharon Valida. Jack Halliburton."

The changeling extended its hand. "We've met, briefly. I work at the Pacific Commercial Bank."

"And have a good memory for faces."

Especially yours, the changeling thought.

"Hot dog?" Russell said.

"No, I'm headed for the hotel. I saw you here and wondered whether we might get together a little earlier tomorrow morning, before the . . . thing."

"Like what, eight o'clock?"

"Eight would be fine. I'll leave a message for Jan." He nodded at the changeling. "Miss Valida. See you then, Russell."

When he was out of earshot, the changeling said, "He always dresses like that?" White linen suit, Panama hat, Samoan shirt.

"Yeah, when he's not working in the lab. Maybe a century out of date."

"A few other rich old guys who come into the bank dress that way. My boss calls them his Somerset Maugham characters. Was he some actor?"

"Writer, I think." He ate the last bite and stood up. "Ready for another?"

"Let it get a little burnt. Try a beer, though."

"Excellent idea." He took two Heinekens out and popped them.

She drank off her wine and accepted one. "Here's to drunken debauchery on Sunday." They clinked bottles together. "So showing Newton a hologram."

"Well, it's occurred to me that this thing might not be from another planet. It might be from our own future."

"Really? I thought you could only go the other way."

"You know about that?"

"I saw a thing on the cube. Particle accelerator."

"Yeah, they've been able to move a particle a fraction of a second into the future. Which is kosher; general relativity has always allowed that."

"But not into the past?"

"That's right—and it's not just relativity; it's causality, common sense. Cause and effect out the window."

"But you think—"

"I know it's like 'one impossible thing happens, therefore anything impossible can happen.' But it makes a screwy kind of sense. They sent this indestructible thing back a million years into the past, and put it where no one could find it. Then they went to dig it up . . ."

"And it wasn't there!" She nodded rapidly. "So they sent this kind of robot back here to find out what happened."

"Not a robot," he said. "Definitely not a robot."

"You knew her?"

He hesitated. "Pretty well. Or I thought I did. She was pretty human for a robot. Or transhuman, as I say, from the future."

"Evolved from humans?"

"Bingo. It wouldn't take millions of years, either. It's only law and custom, not science, that keeps us from directing our own evolution now."

The changeling considered this. It seemed to have memories going so far back that it always considered itself a visitor from the distant past. It *could* have been from the future, though, and lost the memory of that travel.

It knew that a way around the causality paradox might be that the time traveler not be allowed to take any information back in time. It had never thought of applying that to its own amnesia of the time before the centuries it had

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spent as a great white shark. It could have been sent back as a blank-slate creature that *needed* no memory to survive, and evolve.

"Have you talked this over with Jack?"

"Jack? No. He's all for aliens from another planet. Especially since the thing with Rae, our 'space alien.'"

"Which you don't buy."

"Well . . . I guess you can make a better scientific, or at least logical, case for extraterrestrial origin. But if so, why didn't she just come forward and say 'Take me to your leader'?"

"Maybe she was afraid."

"She wasn't afraid of me."

"Maybe Jack." The changeling smiled. "I take it she wouldn't be the only one."

"He's a little scary sometimes." He got up and turned the hot dogs. "Let's burn the other side."

She didn't say anything while he repositioned the meat and buns. When he looked up she was staring out to sea, an odd thoughtful expression on her face.

"Sharon?"

It was a song. *A song.*

The changeling never stopped manipulating the ones and zeros. Pretending to be human only used a small part of its intelligence, so while it was carrying on bank business or being social, most of its being was swimming through the binary sea of the message.

The message itself wasn't clear, but suddenly the changeling knew *what* it was.

A song in its native tongue. A language forgotten for a million years.

"Sharon? Are you all right?"

"Oh! Sorry." She rubbed her face with both hands. "Sometimes I do that."

He sat on the bench, not too close, and touched her hand. "Is it your parents?" She shook her head in two short jerks. "I lost mine together, too, at least in the same week. I was quite a bit older than you, but it still hit me hard. Being alone."

Her eyes brimmed and she wiped them. "You're right. Alone." He's a wonderful man, it thought, but he doesn't know what loneliness is.

He wanted to take her into his arms, but restrained himself. "Let me take you home."

"No. It's passed." She flashed him a bright smile. "Let's have another hot dog." She peered into the empty beer bottle. "Maybe the beer makes me sentimental. I should have another."

"Your wish is my command." He opened two and passed her one. "Sentimental together."

A song. A song about home. "Are they burnt enough?"

He touched one lightly. "Done to a turn."

While they ate and chatted about deliberately inconsequential things, it made plans for the rest of the day and night. Especially night. Russell was in for a little surprise.

Tomorrow, they were almost certainly going to announce that the artifact had answered them, and perhaps release the binary sequence, so that a few million other people could try to figure it out.

People wouldn't. It would be like someone who didn't know what Braille was running his finger along a line of it, in a foreign language. A coded message, not coded for secrecy, but nevertheless unbreakable.

But by Tuesday, there would be outsiders all over the place. Reporters lucky enough to be in American Samoa would be on the spot by noon Monday. The Tuesday morning plane would be crowded with them, from America; Thursday, from Asia and Europe. Security would be tighter around the clock.

So it had until tomorrow morning.

"I don't want to rush things," Russell said, "but are you doing anything tonight? If I don't have an excuse, Jack's going to collar me at Aggie's."

She closed her eyes. Careful. "I wish I could. But I'm going out with a man from work." She patted Russell's knee. "Have to tell him I'm not interested. Free

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Monday and Tuesday, though."

"We already have lunch Monday," he reminded her.

"Dinner Tuesday, then."

"I'll make Sail reservations at eight, right away. There'll be a lot of hungry reporters in town."

The changeling nodded. "And I'll know the big secret by then."

"By ten tomorrow, if you listen to the news. Or you can wait and let me surprise you at lunch."

"Maybe I'll wait. I don't suppose you'll let me try to guess."

"Nope."

"You've discovered the president's an alien."

"Damn, you got it. Now we'll have to kill you."

"Oh, well. At least I found out early."

They pedaled around Apia after lunch, stopping at the Maketi Fou, the normally crowded central market, for iced coconuts. On Sunday it was pretty lazy, the vendors chatting in clusters in shady spots, reluctantly coming over to take their money. He bought her a mother-of-pearl necklace she admired. She bought him a garish silk crimson lava-lava and dared him to wear it to dinner.

The changeling wondered whether there would be a dinner date. Their relationship was about to enter uncharted territory.

Maybe he *would* have to kill her, in a sense. In the sense that she was Rae, was Sharon.

Russell offered to let her keep the bicycle, but she said no, she didn't want to either leave it outside or lug it up the stairs to her small apartment. She left it at his cottage and kissed him goodbye, firmly, and walked the few blocks home with the kiss fading on her lips.

The changeling pulled the shutters closed over its window and lay in the half-dark, listening to the click of the ceiling fan and the chatter of birds in the poinciana tree outside.

It began to practice the language it didn't yet understand. With its glottis it made clicks exactly a twentieth of a second long, for ones, and carefully measured pauses, for zeroes.

Early on in the message, there were three clusters of the sequence 000011110000, which were probably separators of some kind, and a fourth one just past midway. These divided the message into parts roughly 2:1:1:47:49. In analogy to human music, perhaps it was a two-verse song, preceded by three packets of information: the first identifying it as a song, and the other two giving the title and some technical information, like tempo and key signature. Or flavor and electrical charge.

There was no obvious pattern to the two verses, though each one had imbedded the cluster, or word, 01100101001011—three times in the first verse and four in the second. There were no other long repetitions. Short ones, like 0100101, had no statistical significance, but if they represented words in a human language, they could be common ones like "a" or "the."

Not much to go on, analytically, but to the changeling it had some intuitive or subliminal meaning, evocative but frustrating, like a melody heard in childhood and almost totally forgotten.

The ceiling fan made a click each 3/4 second. The changeling used it as a metronome, or rhythm section. Its human glottis could "speak" about a third as fast as the artifact had; it lowered the pitch of its sounds by a factor of three.

It practiced quietly enough so that someone eavesdropping would hear something that sounded like noise from the fan's motor, which is exactly what the CIA woman in the next room concluded. They had moved in a few hours after Sharon had her first lunch with Russell.

It didn't take long for the changeling to memorize the 45-second sequence of clicks and silences that it wanted to sing back to the artifact. But of course it couldn't get in there without Russell, so

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it had to wait until dark, and then some. If Russell had met Jack for dinner, he probably wouldn't be out too late. Would he then go to the lab, or home? Usually, it knew, he would go home for some light reading, listening to music, and since he'd be tied to the lab most of the next day, that's probably what he'd do.

At nine, it put on a cute black outfit, short skirt and a clinging buckyball top that shimmered shifting rainbows like a blackbird's wing. It slipped out quietly and with precise timing, when it heard the CIA agent go into the bathroom. By the time the agent suspected Sharon's apartment was empty, the changeling had quickly walked the half-mile to the cottages.

The blinds were drawn on number 5, but the light was on by his easy chair. The changeling could visualize him sitting there with his book and glass of wine; a soft harpsichord tinkled the Goldberg Variations.

She stepped out of her shoes and tapped on the door. When he opened it, she slipped inside and eased it shut behind her. "I'm impulsive. Are you?"

It took him a couple of seconds to nod, staring. "With you I could be."

The cottage was one big room with a divider setting off the "bedroom"; she led him there, turning out the reading lamp on the way.

"Just a second." He stopped to light a candle, as expected. In its light, she stripped out of the skirt with a Velcro rip and pulled off the buckyball thing. Underneath, she was wearing nothing but the hummingbird tattoo.

She sat on the bed and pulled him toward her, unbuttoning his silly shirt while he fumbled with his cut-offs. She crawled up and straddled him, helping him in slowly with a circling motion, sighing with genuine pleasure. Being with him as Sharon had not been enough.

She smiled down on him, playing with his hair while he moved up and down inside her, and after a minute said, "I have a little trick." She eased sideways and tilted a bit, raising her knee and straightening her leg, holding him in place. She slowly crabbed around, doing the same trick with the other leg, so that she was facing away, without having lost him in the process. "Still there?" Knowing that he was.

"How . . . did you do that?"

"Double jointed."

She knew he liked this aspect, and enjoyed the internal difference herself, but mainly wanted to be facing the other direction for a few minutes. He clasped her with his hands and she used hers in a practiced way, trying to control his progress while she worked on changing her face.

When the time was right, she had an enthusiastic orgasm, and he ejaculated with desperate eagerness right afterwards. She eased down to her side and he rolled over, holding her spoon fashion.

After a minute he somewhat surprised her: "Rae?"

She turned around in the circle of his arms with her new face, the old face.

She ran a finger down the bridge of his nose while he stared. "'To see love coming, and see love depart.'"

"You . . . grew a new arm," he said inanely. "But you're the same inside." For ninety years, the changeling had always been nurse Deborah inside, whenever it was a woman.

He explored her face with his hands, and then drifted down to the tattoo. "But except for the face. . . ."

"I'm still Sharon. Changing bodies takes longer, and hurts."

"Who . . . what. . . ." He was still caressing her. "What are you?"

"'Who' I am is Sharon and Rae and a couple of hundred other people over the past century, and a number of animals and objects besides. The 'what' is difficult."

"Another planet?"

"I don't even know that. Your idea

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about my coming from the future isn't inconsistent with my memories, which are vague before 1932. I think that's when I first took human form."

"What were you before that?"

"A variety of creatures. I was always in the sea—great white, killer whale; whatever was at the top of the local biome's food chain. Pretty good survival instinct, I suppose.

"I could have been there as long as the artifact; the artifact might have brought me here—from the future, from another star, another dimension. I feel a compelling attraction to it."

He nodded slowly. "So you seduced me, hoping I could—"

She kissed him on the cheek. "Which doesn't mean I don't love you," she whispered. "You can love someone and use him. Or her."

He didn't say anything for a long moment. He smoothed a strand of hair off her forehead, and smiled. "You seem so feminine. As Rae, as Sharon, and now in between."

"I prefer being female. But I was a Marine in World War Two, a male juggler in the circus. In the '70s I was a male astronomy graduate assistant at Harvard, a few years ahead of Jan; I graded Jan's papers when she took Atmospheres of the Sun and Stars. Small world."

"Did you ever meet Jack or me, before the project?"

"No. I knew about you, from the *Titanic* thing, of course; I was a marine biologist."

"As well as a Marine." He shook his head in wonder. "And now?"

The changeling pursed its lips. "Let me get us a glass of wine." He shifted to rise and she put a hand on his shoulder. "I know where it is."

She crossed to the kitchenette and felt his eyes on her; knew how she looked in the candlelight. "I wanted to take more time. Wanted you to fall in love with me as Sharon."

"You were on the right track."

She filled a crystal glass with red wine in the darkness. If he could have seen her face he would be startled, irises the size of quarters. "But I had to force the issue, I thought. Because of tomorrow."

"You know what's happening tomorrow?"

"Easy to guess. I know about the artifact's response, of course, as Rae. You decided to go public. I suppose to lure me out of hiding." She handed him the glass.

He took it without drinking. "Also to get a few million more people working on the sequence. Bigger computers." He sipped and handed the glass back to her. "Why didn't you just identify yourself? You'd be part of the project in a nanosecond, and we'd protect you from . . ." With a jerk of his head he indicated the people who had shot her.

"If you could." With the back of her fingers she stroked the stubble on his cheek. "I know human nature, darling, maybe better than you do. An outsider with almost a century of observation."

"You know love."

"I've known it a few times. I know xenophobia, too. I've been black and Asian and Hispanic in America, in the times when white people could do or say anything to you. A white prisoner on the Bataan Death March. It was a powerful lesson, being hated and feared automatically because you're different." She sipped and put the glass on the end table by the candle. "There's nobody on this planet more 'different' than me."

That was the first thing the changeling had said that wasn't the truth. But it couldn't know that there was someone stranger nearby.

"I have the message partly figured out," she continued. "Not as a Drake algorithm; certainly not as a verbal translation. It seems to be something like a song, and I think it's addressed to me. I want to go answer it."

"Tonight?"

"It has to be tonight. That's why I rushed this."

Russell got up slowly. "I suppose the

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guard would let me take you in. But then what? Most likely, nothing will happen. Will you join the team then? As our resident Martian?"

"Sure. But only you and Jack and Jan would know I wasn't sweet little Sharon from Hawaii, sleeping with the boss."

He rubbed her back. "The night guard is going to be either Simon or Theodore. They'd both recognize Rae. Can you become Jan? Her face, that is?"

"Easy. Five minutes." She got up.

Russell touched her hip. "Wait. Can I watch?"

The changeling turned. "No one's ever seen me do it." Russell nodded. "Okay." It sat back down, facing him.

It winced and there was a slight grinding noise as the cheekbones became more prominent and moved in closer to the nose. The chin lost its dimple and elongated. Wrinkles and laugh lines grew, and the skin under the eyes sagged. The eyes snapped from pale blue to brown. The hair grew to shoulder length and turned white, and then spread out and wove itself into a French braid.

"How can you do that? The hair, it isn't living tissue."

"I don't know how I can do any of it." She stood and spread her arms. The skin of her beautiful body rippled and faded to dead white, and turned into a nylon jumpsuit. The skin on her hands grew age spots and wrinkles.

He rubbed the nylon on her arm between thumb and forefinger. "You can make synthetics."

"Metals, anything. Back in the '60s I spent a week as a motel television set. That was educational."

"Transmutation of elements?"

She smiled at his expression. "I know. I have a pretty recent doctorate in astrophysics. The wildest edge of physics can't explain it.

"I think the only constraint is mass. If I turn into a person or thing considerably heavier or lighter, I have to gain or lose flesh. You wouldn't want to watch me consume a leg of lamb. Or an unabridged dictionary."

"That's how you could lose an arm and keep going?"

"Yes. That hurt, because it was an outside agent, and a surprise. If I had to detach an arm to lose weight, it would take a couple of minutes, and look pretty strange, but it wouldn't hurt."

He leaned back and shook his head, staring. "Are there more than one of you?"

"If there is, I haven't found her. I can *become* more than one individual; given an hour, I could split this body into three children. But the personality, the intelligence, becomes distributed, and weakened. I made myself a school of fish once. Each individual fish was pretty dumb."

"So you haven't reproduced that way. By fission, like an amoeba."

"In fact, I have some sort of instinct against it. When I'm split, I'm anxious to get back together.

"I've wondered sometimes how they do it at home—wherever or whenever I came from. Maybe they don't reproduce at all. Why would immortals have to?"

"You can't *know* you're immortal, can you?"

"Not until I survive the heat death of the universe, no. But I've been through a lot and always seem to recover." She stood and carried the candle to the bureau mirror, and inspected her transformation. "Shall we go?" she said in Jan's voice.

"In a minute. Some of us have to dress."

They were only five minutes from the project. They said hello to a few people out enjoying the night air or sitting on their porches, no doubt adding grist to the rumor mill—people did suspect a romantic attachment between the two senior researchers.

The guard was Theodore, a large cheerful Chinese-Samoan. "Nervous about tomorrow, professors?"

"You know about tomorrow?" Russ

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said.

"Just that there's something; something big. Simon told me."

"They probably know in Pago Pago," the changeling said.

"He told me it was a secret."

"Still is, I hope." Russell gestured. "We're going into the artifact room."

"Okay." He reached down and clicked something. "It's clear."

They went in by the reception desk and walked down a silent corridor to a blast door covered with warnings. Russ unlocked it with his handprint, and the heavy door sighed open.

In the anteroom there were two complex data consoles. He sat down at the larger one and typed a few lines. "Okay . . . I've turned off the cameras for maintenance. That'll be fun to explain."

"I'll look at it on the way out," the changeling said. "I think I can cover it."

"Computers, too?"

"MIT. I've had a long time to study things." It opened a locker. "Should we suit up?"

"Don't have to. Nothing nano going on." He put his hand on another door. "Open for me," he said quietly, evenly, and it slid away into the jamb in absolute silence. It was an airlock chamber. An identical door, without the ID plate, was on the other side.

They stepped inside and he said, "Close."

The door behind closed, but the one in front didn't open. "There are two people in the airlock," the room said. "I need a speech pattern from the one who is not Russell Sutton."

"I'm Jan," the changeling said. "Open for me." The door slid open and they stepped into the long corridor that connected the artifact room to the main building. Fluorescent lights winked on as the door slid silently shut. The windowless metal walls were full of clutter; people had put up cartoons and drawings with refrigerator magnets, and a galaxy of magnetized words coalesced into clusters of poetry, not all of it obscene.

One block of wall several meters long contained 31,433 ones and zeros.

A final blast door, thick as a bank vault, that opened on to the artifact room, was halfway open. As they passed through it, a bank of floodlights over the artifact came on with a crackling sound.

The changeling stepped toward it hesitantly, Russell holding back.

She touched it and recoiled as if from an electric shock.

"What is it?"

She shook her head and started to trill. It was an unearthly sound, and no human could have done it, glottal stops modulating one tone in rapid-fire Morse code.

It was over in 45 seconds. They both stared at the artifact.

The chameleon stepped through the vault door behind them. "That was interesting." The door closed with a dull boom.

Russell whirled around. "Jack! Jan and I were—"

Jack waved his hand in a gesture of dismissal. "I've had a microcamera in your bedroom since you first moved into the fala. It's often been entertaining, but never so much as tonight."

The changeling crossed her arms. "So you know what I am."

"Actually, no." It spread its arms, palms up, and in an instant became a duplicate of Russell.

"That's good," she said.

"You can't do it, can you? I watched you take several minutes just to change your face. But you've only had a century of practice."

"How much practice have you had?"

"Since the Stone Age. But I can't remember it not being instantaneous." It changed back into Jack and walked toward her.

"Do you know where we're from?"

"I don't think it's 'we,' dear. I can't become a television set or a great white shark or even a female. I can look like any man, but that's it. We're different

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species."

"But maybe from the same planet, or time."

"Or dimension, whatever." He stood directly in front of the changeling and studied her.

"So the project," Russell said, "it was just a lure, to find—"

"That's right." He didn't take his eyes off the changeling. "I discovered the artifact some time before the submarine had its 'accident.'"

"Which was no accident," the changeling said.

"Go to the head of the class. A rear admiral can get a lot done in the Navy. I had her vectored close to the artifact and set off the charge that sank her."

"A hundred twenty-one dead?" Russell said.

Jack ignored him. He reached out and gently took the changeling's wrist. "The arm's all healed?"

She cocked her head. "Of course."

He pulled down hard and the shoulder socket popped like a gunshot, and the arm tore free. An instant later her other hand came up and struck his face so hard the lower hinge of the jaw broke off and swung free.

He staggered back and threw the arm away, and used both hands to press his chin back into place.

"What are you doing?" she said. After an initial spray, the bleeding from her shoulder stopped.

It took a moment for the jaw to fuse back into place. "I'm doing . . . what I've lived for, for thousands of years."

"Why?"

"Only one of us per planet."

"I'm not one of you."

"But you are—" Russ leaped onto his back and put a scissor-hold on his throat. The chameleon threw him off like a doll, to crash against the heavy laser mount.

"You are my only rival here. This is not personal. You just have to die."

She sidled around to where Russ was lying still. "It became personal when you hurt him. And I can't die."

"I believe I can put you into a state equivalent to death. All I have to do is tear you into several pieces and make sure those pieces stay separate. For all time."

The changeling found a pulse in Russell's throat and stood between him and the monster. "I could do the same to you."

"Not with one arm, I think. You won't have time to grow a new one, and you can't leave this room to do so at leisure."

She looked at the walls. "You're wrong. I could be through that wall and in the water in seconds. I don't think you want to face me in the water. Even one-armed."

"Leave and I'll kill him. Your choice."

The changeling hesitated. Jack couldn't let Russ live, no matter what happened to her.

"Go ahead," the chameleon said. "I won't even try to stop you. You'll be back, and meanwhile I'll enjoy killing him slowly. He hasn't been easy to work with."

She tried another tack. "I don't understand you. You're like a scientist who's searched all his life for something, but when you find it, want to destroy it without learning anything first."

"I learned enough before you left that bedroom to come here. And I'm no more a scientist than you are a woman." He suddenly looked left. "Well, isn't *that* cute."

The amputated arm was transforming itself into a weapon. The nails had become long metal talons and eyes had formed over two knuckles. Pseudopods along the sides were turning into insectoid legs.

He turned back to the changeling. "Let me show you what I looked like when I first started looking for you." He became more than a foot shorter, bulking out so much that his T-shirt and shorts split. Black hair bristled all over his body and his face coarsened into Neanderthal features. He tore the rags of

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clothing away to reveal massive ridges of muscle and prominent genitals, engorged.

She leaped at him and he casually kicked her aside, the rough horn of his toe claws ripping cloth and skin between her breasts with a crunch of broken bone. She rolled once and came up in a crouch, pale, uncertain.

He stroked himself for a moment, looking at her, and muttered, "No."

"Please try." She tensed.

Without looking at it, he struck sideways with the speed of a serpent and snatched up the disembodied arm. Wriggling, it tried to fight, but he closed a hand over its claws and bent back until they broke. He threw them to the floor with a clatter and then stripped the legs off like someone cleaning a shrimp.

He bit at the bicep and tore off a strip of flesh and then, munching it, broke the arm at the elbow. With a long dirty thumbnail he daintily excavated the eyes over the knuckles, and popped them in his mouth.

He smiled, his teeth pink with her blood. "Grendel meets Joan of Arc," he growled.

The changeling looked around the room for something it could use as a weapon. It was too neat; there was nothing loose. The huge laser could cut the creature into chunks, but it was immovable as a boulder and could only be activated remotely.

Russell had regained consciousness and was staring at the horrible scene. The chameleon had stripped almost all of the flesh from the bone above the elbow. It dropped the arm and spit out a large gobbet. "At this point I should say 'You have wonderful taste, my dear,' but in fact you don't. I don't think I've ever eaten anything as vile as you."

"You're the first creature I've ever known to take a second bite. You're the one with no taste." She saw Russell fumble in his pocket and come out with his Swiss Army knife. "No, Russ!"

The chameleon turned to look at him and laughed. "Wrong tool, Russell."

"Oh?" He half-turned and jammed it into a high voltage wall socket. There was a shower of sparks and the shock knocked him flat. The lights went out.

The backup, a large gasoline-powered generator, came on in a second. The lights flickered and then returned to normal brightness. Russ sat back up, cradling his injured hand.

"That didn't buy you any time."

"That wasn't the point. People will come to investigate."

"They'll find they can't get the blast door open."

"You really haven't thought this through, have you? You kill us and then what? Call a press conference?"

"I'll just leave the way she—" He turned, and she wasn't there any more.

The changeling dropped from a ceiling girder just as he looked up. She landed on his shoulders and gave his head two twists, and his neck snapped. But he had hold of her leg by then, and flung her off in a high arc. She landed heavily and rolled to the base of the artifact, not far from Russell.

By the time she stopped rolling, it had changed its face, a grotesque combination of the Neanderthal and Jack. "That did hurt. Shall we play pain?"

Pulling herself to her feet, the changeling reached up and touched the artifact.

There was a sound like a distant large bell struck once.

The changeling took its true form for the first time in a million years. It elongated until it was about eight feet long. Its face had only one opening, with no apparent sense organs. You couldn't focus on its body—it changed, moment by moment, colors shimmering all over the spectrum, limbs growing and fading and transmuting. It was inhumanly beautiful.

The artifact flowed off its stand as if it were mercury. It shot in one straight rivulet toward the chameleon and formed itself into a domed cage around him.

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The changeling spoke to it, in colors.

The chameleon seized the bars of its cage, but they wouldn't budge. Then it spasmed into rigidity, and then froze, literally, frost riming all over its body.

The artifact melted into a puddle all around the chameleon, and then reformed as a large silver ovoid, three or four times the size of its original manifestation, with the deadly creature inside. Colors flashed all over the room, and then stopped, and the changeling became Jan again, flickered through Sharon, and settled on Rae.

She walked over to Russ, took his hand, and helped him to his feet. She embraced him.

"What was . . . was that you?"

"It's news to me, too, but yes. I guess that's what I look like when I don't have to look like something else."

There was a loud creaking sound, and a large part of the ceiling dropped a few feet, then stopped, turned sideways, and settled slowly to the floor, leaning neatly against the wall.

"The artifact is sort of like my partner, alive in its way. It didn't realize who I was until I touched it. That sort of woke it up, too; it's been in a kind of waiting mode, suspended animation, since I left it to explore."

"Ninety years ago?"

"More like a million." She looked at the ovoid. "It doesn't know what Jack is, but he obviously shouldn't be allowed to remain on Earth. We'll take him home for study."

"He's not dead?"

"No. He can't die any more than we can. But he's not from our world."

"Where is your world?"

"Ten thousand light-years away. A planet in a globular cluster—Messier 22, in Sagittarius." She gave him a long kiss. "Get a telescope and look me up some time."

"You have to go."

"Yes. It's like a law. I've been here for too long. Done things I shouldn't have done. Like fall in love with a local, an alien."

"Well . . . I know how that feels." She squeezed his hand and started to say something, but turned and walked toward the ship. An entrance rippled open. "Could I go with you?"

She smiled at him and shook her head. "The journey's too long. And you'd have to learn how to breathe chlorine." She looked at him for a long moment and stepped into the ovoid. The entrance resealed.

The ship silently rose to the ceiling. But then it settled back down to the floor. It opened again.

The changeling was in its natural form, splendid, chaotic. It became Rae again.

"Actually, the ship says you *could* come. But not as a human. You'd have to let it change you into something like me."

Suddenly, loudspeakers crackled. Jan's voice, painfully loud: "Jack? Russell? What the hell is going on in there?"

Russell shook his head and laughed.

"Russ, the guard says you went in there with me! What are you doing?"

"Just . . . taking a little trip." He stepped over the threshold and felt himself start to glow. ■

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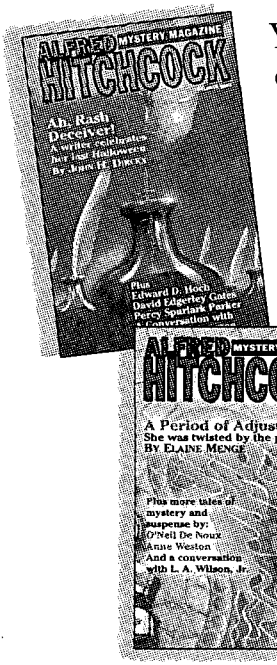

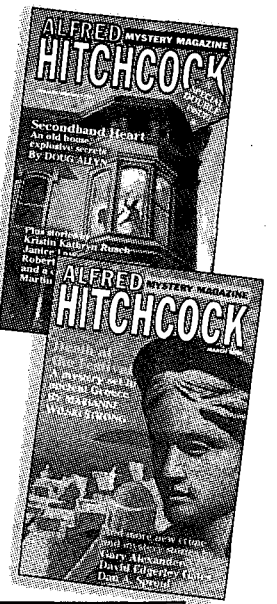

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Petting the Time Shark and Other Poems, Mike Allen, DNA Publications (P. O. Box 2988, Radford, VA 24143-2988; www.dnapublications.com), $5 + $1.50 s&h, 48 pp. (ISBN: none).

Don't Panic: Douglas Adams & The Hitchhiker's Guide to the Galaxy, Neil Gaiman, Titan Books, $21.95, 243 pp. (ISBN: 1-84023-742-2).

Scores: Reviews 1993-2003, John Clute, Beccon Publications, $27 (pb), 428 + x pp. (ISBN: 1-870824-48-2).

Orson Scott Card's *Tales of Alvin Maker* series has earned great praise here and elsewhere. Part of the appeal lies in Card's superlative skills as a storyteller. Part lies in the world he has created, an alternate frontier America, where history differs and Appalachian-style magic works. Notably, many people wield knacks—more than mere talents—that make work simpler and easier. Alvin Maker, the seventh son of a seventh son, has the knack of shaping stone and iron by his will alone. His implacable foe is the Unmaker (read: Satan) and its minions, the forces of erosion, entropy, and chaos. And through five books now, he has grown and triumphed and struggled toward a dream of building the Crystal City, the City of God, whose citizens will all be Makers much like Alvin.

The books of the series to date have been *Seventh Son* (reviewed here in Mid-December 1987), *Red Prophet* (September 1988), *Prentice Alvin* (August 1989), *Alvin Journeyman* (January 1996), and *Heartfire* (October 1998), in which last Alvin's wife Peggy embraced the battle to free the slaves while Alvin himself fought against witchcraft

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charges. Now, in **The Crystal City**, Card sends Alvin to Nueva Barcelona (a.k.a. New Orleans). Alvin's rather glum about his failure to teach others how to be makers like himself (although Arthur Stuart, the black boy whose very genes Alvin had to alter to protect him from the slave finders, has learned a great deal). His dreamed Crystal City seems never to be. Add to this that he doesn't know what he's in Barcy for, other than that Peggy sent him there, and you've got a nice case of depression brewing.

But before long Alvin has discovered the slavery battle himself, remembered earlier lessons in the solidification of water, and created a bridge across Lake Pontchartrain across which thousands of the city's oppressed slaves and poor may escape. Yet they are pursued, until Alvin reaches across the Mississippi to ask safe passage of the Red Indians who have made it their own and barred it to the whites.

What next? Well, he's dragging a city's worth of folks in his wake, he's got old friend Verily Cooper and Abe Lincoln himself to deal with land claims and such, and before long everyone is pitching in to build a city. The material they use makes it a Crystal City, too.

Card makes quite explicit the analogy with Moses, Pharaoh, and the Red Sea, but his real point is that to make something one must put into the made something of oneself. By extension, all who put of themselves into a communal effort are makers. So the dream is fulfilled.

I omit an immense amount of detail: Self-centered and jealous brother Calvin hooks up with Steve Austin and Jim Bowie, heading out to fight not the Spanish Mexicans but the Aztec Mexicans, who have already defeated the Spanish and offered their hearts to the sun. Mike Fink is here. The golden plow finally discovers its destiny. And more . . . There's nothing to say this is the end of the saga, but if it were, we could feel very satisfied.

* * *

Scott Westerfeld began his "Succession" duology with *The Risen Empire*, describing a realm of eighty worlds ruled by the dead. Some sixteen centuries past, a researcher conquered death by finding a way to reanimate the dead with a synthetic "symbiant." Immortality was at last achieved, the researcher committed suicide so he could be the first, and he became the Emperor. Ever since, the rich, powerful, and loyal have been rewarded at the end of their natural span with the symbiant.

Society is divided into the dead, the gray (who support the status quo), and the "secularists," who hold that people should not accept the symbiant. Die, they say. Let go, so the future can live. Nara Oxham is a Secularist senator who loves the gray warship commander Laurent Zai, who has been sent to fight the Rix, who seed worlds with planetary intelligences. He failed to save the Emperor's sister, the Child Empress, and protect the secret only the Emperor and his political apparatus know exists. Ordered to fall upon his blade but told to live by Nara, he defies tradition and lives.

So of course the Emperor orders him into a suicide mission against the Rix battle cruiser. As **The Killing of Worlds: Book Two of Succession** opens, the battle is about to be joined. Westerfeld shows a nice hand at describing the action. It's a tenterhooky sort of thing for pages and pages! Zai prevails, but then a new object appears in space and the newborn planetary mind—Alexander—transmits itself to the object and gains a colossal body made of "programmable matter." Alexander also quite admires Zai and wonders if Zai can become an ally.

When it becomes clear just how far the Emperor will go to protect the great secret and just how much he has it in for Zai who refused to die, Nara must consider whether to sacrifice herself. Zai must consider where lie his true loyalties. And . . .

Well. Last time I wondered which of

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the several meanings of "succession" Westerfeld meant. This time he makes it clear from the outset that the Empire is about to fall. There will be civil war, and someone else will be in charge for awhile.

The cover copy says this concludes the tale, but there is room for more. Perhaps Westerfeld will oblige the fans he has earned so far.

Hayford Peirce's **Black Hole Planet** begins with a crew of aliens collecting "Fire People" from "Ice Planet" as samples to be preserved after alien colonists have thoroughly taken over their world. They are loading the last specimens when something goes wrong. Aldahax and one of the Fire People are trapped in a slow-time chamber, waiting for rescue.

Cut to our immediate future, when Remo Rydel and his lovely and beloved wife Kalpurna are working on a massive asteroidal sculpture. Kalpurna is stricken with a fatal illness and must be popped into the medevac capsule and shipped off to the clinic on Ceres. With his instruments, Remo follows her trajectory, full of hope, and when she vanishes, he is quite beside himself.

But life goes on. He gets a gig mapping asteroids, which allows him to search for her. And then one day his ship is drawn willy-nilly into a cavern in an asteroid. There's the capsule! But there too is an alien ship, a bit battered, full of desiccated alien bodies and prehumans.

And, of course, a still-working slow-time chamber occupied by alien Aldahax and australopithecine Proharahara ("Ice Planet" was Ice Age Earth). Soon they are off to the alien world of Second Dawn, which orbits a small black hole which it uses to tour the galaxy, to discover that in the last million years or so Proharahara's folk have evolved to impressive intelligence. Second Dawn is a hotbed of unrest and political scheming, and the question of whether Kalpurna can be awakened and healed is left up in the air until the very end.

An entertaining adventure, a bit in the retro mode, and quite suitable for young adults.

The kids have a century to go before they can be called adults, and their brains are of tougher substance than mere meat. But they are nonetheless human, some ten million years after the Great Wars that threatened humanity's existence were settled by selecting and gifting with powers well above the norm a thousand good individuals, each to found a Family of clones who settle disputes, reconstruct worlds, and in general do Good Things.

Back to those kids: they're having a snowball fight, one team ensconced in a fort, the other attacking with such things as heat mortars. Ord is a Chamberlain, a Family renowned for great deeds. Ravleen is a Sanchex, whose genius is military. Xo is a Nuyen, a clan of bureaucrats and schemers. Even the kids seem infested with rivalries and jealousies, and the reader may be forgiven for wondering just how the Great Wars have stayed quiet so long.

And now an ancient Chamberlain, **Sister Alice**, appears in the ancestral manse. She is, it emerges, fleeing a disaster, a wave of devastation propagating from the Galactic Core outward into the galaxy. She speaks rather cryptically with Ord, the Baby of the family, and when it becomes clear that she has come to bear the blame for the disaster (which she *did* have a major hand in creating), Ord must flee on a mission he only dimly grasps.

He is fortunate to be away, for galactic civilization—led by Nuyens and others of the Families who want to seem thoroughly disassociated from the disaster—is now bent on exterminating all the Families who helped make it happen. Ord is a fugitive, laden down by vast amounts of Alice's super-tech "talents," and no matter how hard he tries to redeem his own and his Family's name, he

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is hounded on and on, eventually toward the Core and the fountainhead of catastrophe. Chief among his pursuers, of course, are Xo and Ravleen.

Reed is a well established writer, with a reputation for deft story-telling, originality, and plenty of scope and grandeur. All that is on display here, but I was less than fully satisfied for a simple reason: These folks have managed to maintain peace and prosperity for ten million years. But they remain pig-headed, bloody-minded, stupid, and venal. How did they manage to keep all that in check through all the disasters that had to stud ten thousand millennia? They *had* to happen on the local scale, after all, over and over again, and local disasters—from comet impacts to supernovas (the folks of Reed's future can survive mere car crashes, earthquakes, and such)—are quite the end of the world to those involved. A galactic-scale disaster is worse, of course, but the grandest catastrophe is a mosaic of small catastrophes. And if those smaller ones have not awakened the beast in ten million years, why now?

I suspect the answer is simply that Reed needed a story. He had a great setting, a grand situation, and some nifty characters; if he had to use an idiot plot (which in this case requires an entire civilization to turn idiot) to make it all work, so be it. Being Reed, he still produced a very readable and entertaining novel.

But still . . .

James N. Gardner might, I think, like to be rated as Darwin's equal on the strength of **Biocosm**, but where Darwin amassed evidence to construct a seminal theory, all Gardner amasses is speculations and metaphors.

The speculations come from some of the finest minds in physics, cosmology, and even biology, and they converge on some delightfully sfnal notions (writers such as Robert Reed would surely agree!), but speculations is all they are, dreadfully contingent on the current state of thinking about brane theory and dark matter, Omega Points and budding universes, and so on. The metaphors . . . some even come from SF!

Here's the thrust: Theory suggests that many universes are possible, with variations possible in such "constants" as Planck's constant and the speed of light. In our universe, life and intelligence appear inevitable consequences of physics and chemistry, highly dependent on our universe's particular constants. Why? Sheer fluke? Are we only impressed by our own hindsight? Or is something queer going on?

Universes, Gardner suggests, reproduce, budding off baby universes with constants like their own. Their reproductive mechanism is life and intelligence; that is, the purpose of humanity (in due time) is to build the appropriate apparatus to let our universe have a baby.

Maybe so. It's a cool idea and one that SF writers have played with before. But I am not convinced by hyperventilated appeals to the Big Names of science as if their stature should lend wild-eyed speculations impressive solidity. That said, Gardner writes interestingly, assembles interesting ideas, and treads fearlessly into territory where—if only the theologians would take him seriously—he would be expelled on grounds of sacrilege and heresy. Fortunately and wisely, Gardner refrains from saying that the precedent of Darwin and Galileo (and others) makes his heretical claims as right as theirs. If he were less wise in this, he would be just one more crank.

He's clearly in love with his own ideas, but he is very constant in calling them speculations. Enjoy them on that basis, and have fun trying to imagine the stories they might lead to—before your favorite writers get similar tales onto the bookstore shelves.

Chad Oliver (1928-1993) was a professor of anthropology at the University

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of Texas. As an SF writer, he produced a body of work—short stories and novels—that earned him the admiration of both readers and other writers. As a Western writer, he copped every award in sight. Now the New England Science Fiction Association brings him back with two volumes of forty "selected stories," from "Blood's a Rover" (*Astounding*, 1952) to "Meanwhile, Back on the Reservation" (*Analog*, 1981).

For an ample helping of excellent and memorable stories, order **A Star Above It** and **Far From this Earth.** You won't regret it.

Michael Swanwick has a sterling reputation and a shelf full of awards to prove it. The last of his novels to be mentioned here (in May 1998) was *Jack Faust*. Now he shows us that perhaps Faust has been dwelling on his imagination in **Cigar-Box Faust and Other Miniatures**. The title story was written for his wife and performed on a tabletop when she returned home from work.

But that accounts for only three pages of the total. The rest includes a number of brief curiosities he claims to have written in his sleep, an sfnal abecedary, amusements at the expense of Picasso and one of the field's prominent editors, and more (over seventy items in all), all deft and witty and many of them blessed with an acerbic bite.

Highly recommended.

Wesleyan University Press has an "Early Classics of Science Fiction" series featuring both novels (Verne and Flammarion) and monographs (Larbalestier's *The Battle of the Sexes in Science Fiction*). Now it adds **Cosmos Latinos: An Anthology of Science Fiction from Latin America and Spain** to give North American Anglophone readers, fans, and scholars a taste of a very different SF.

Editors Andrea L. Bell and Yolanda Molina-Gavilan note in their introduction that Latin American and Spanish SF reaches back well into the nineteenth century (the oldest story here comes from 1862 Mexico). Its development has been hampered by a sense that SF is a thing of the technologically dominant North, and Northern SF is to be taken as a model to imitate. But at the same time, this branch of SF has been stimulated by some of the same forces that shaped Soviet SF, where writers found it congenial as a way to successfully disguise from censors and convey to readers messages critical of an autocratic regime. The editors also note a tendency for Latin American and Spanish SF to be "soft": "the majority of these works do not aim for scientific plausibility. Literary scholars usually attribute this characteristic to the regional countries' role as consumers rather than producers of technology . . . [There is also an] emphasis on the sociopolitical."

That said, the editors provide a good overview of the history of Latin American and Spanish SF and sketches of the major authors (especially those represented here), as well as twenty-seven very readable tales.

Mike Allen, winner of the 2003 Rhysling Award (the Nebula-equivalent for poetry), displays a selection of his work in **Petting the Time Shark and Other Poems**. The title poem views moments as fish scales aimed like the denticles in shark's skin in one direction so that any attempt to move against the flow of time is painful. The image is intriguing and fairly typical of Allen's style, which can present a night sky as dotted thread lines stitching constellations together and discuss with straightest face ectoplasmic appliances, erasure plagues, and lovers duking it out with wormholes and nanobots.

Image, feeling, and even humor. A package worth its price if you like SF poetry at all.

In 1987, Neil Gaiman wrote the first version of **Don't Panic: Douglas**

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Adams & The Hitchhiker's Guide to the Galaxy. Since then a great deal more has happened to the Hitchhiker's cult and canon, and Adams himself died in 2001. It was time to bring the tale up to date, and so Gaiman has done with great lucidity and even wit.

Don't Panic is for the fan who is thoroughly familiar with the canon, from radio to TV and book and comic to movie. Here are background and trivia, people and complications, overall an entertaining reference, just the sort of thing to pick up when you haven't got but a minute and can't bear to see that minute expand to two, then ten, and finally an hour. But it will, and worse than that if you quench your thirst with a Pan Galactic Gargle Blaster or three.

Enjoy.

John Clute has been reviewing science fiction and fantasy even longer than I have, though a better word for what he does is "criticism." His aim is to understand "the central literatures of our era," not just to tell a magazine's readers what is and is not worth reading. To this aim, he brings considerable intelligence, erudition, wit, and keen insight, and he has earned three Hugo Awards, four Locus Awards, and a Pilgrim Award for "distinguished contributions to the study of science fiction." He displays his talents in the pages of *Interzone* and *The New York Review of Science Fiction*, among others.

And periodically, he reassembles his work, with suitable revision, in volumes such as **Scores: Reviews 1993-2003**. Here you will find his thoughts on works by Gene Wolfe, Tom Holt, M. J. Engh, Norman Spinrad, Gregory Benford, Bruce Sterling, and many more, ending with a post-9/11 essay which says that "SF contains in itself the portents of terrible change. . . . We [sf writers] would never literally create an act of terrorism, but the World Trade Center is the kind of sentence we write. This shames the imagination."

He's right, I think. As he is also when he adds that though we "lack the wisdom of gods, [we] now have the strength of gods. We are the Word. We cannot afford to fall silent. . . . We are all going to die if we do not say something good."

Clute is a man worthy of attention. Pay him this due, and let him influence your thinking.■

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BRASS TACKS

Dear Stan,

I love it when you write music columns. By the first sentence of the second paragraph of your "Scarce Skills" column I knew exactly where you were going, but I had no idea you'd get there via transposing. (Playing a C instrument makes one horribly complacent, speaking as one who can barely transpose "Happy Birthday"). These computerized stands were the subject of some discussion on "Orchestra-L" a couple of years ago, till more important things came up. As I recall, the only advantage anyone thought of was that bowings could be

changed from the podium without a lick of work done by players. Myself, I don't think their time will come soon: imagine the cost. Imagine your stand partner wanting the contrast brighter than you do. Imagine the malfunctions, in the middle of a recording of, say, Mahler. "Maestro, I'm so sorry, my music just went away all of a sudden." Imagine Tech Support. . . . (Now why is the very next thing in this October issue a story about tech support/customer service, hmmm?) Imagine the poor stage manager trying to light the stage so that nobody's screen has *any* glare on it. Imagine the wires to trip over. Or, wireless, imagine AFM Distinguished Counsel Lennie Liebowitz on microwave radiation in the workplace. Oh the mind boggles.

I've been telling people for years that one day the orchestra would be able to rehearse and perform in virtual space, when the technology catches up. But I just had an interesting thought- since it would all be digital, could we really play in tune with each other? Could we really actually play together? Hmmm.

Constant thanks for constant good reading!

Christine Ertell,
Richmond VA

Dr. Schmidt,

1) Your October editorial was interesting. My son is a professional musician (band leader, contractor for pit orchestras, music arranger, etc.)—he says hiring musicians for *West Side Story* is one of the more difficult jobs, because most of the chairs require more than one instrument and the music shifts beats and even key. (I am an engineer, not musician, so my terminology may be confusing).

2) The science fact article on rotting plants intrigued me. I am retired, but worked as a Process Engineering Consultant and was a witness as a technical expert at environmental trials. I developed a reputation for "But nobody asked me that before!'

a) For the farm waste from the Midwest, the article did not mention the CO2 produced by collecting, baling, transporting to river barges, and hauling the barges to deep ocean water. (Also, the financial cost!)

b) Most vegetation (especially when dry) floats on fresh water and ocean water is more dense.

c) I can hear the howls from the environmentalists about polluting the ocean. We do not know a lot about the deep ocean. We do know that "black streamers" support life without photosynthesis

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and recently just at underwater cracks in the crust.

Alwien Dierl

Dr. Schmidt,

(Re: "The Power of Rotting Plants" October 2003)

Another old technology might be of use here . . . charcoal.

For millennia, organic matter has been converted to pure carbon (along with some mineral ash) by heating in the absence of oxygen (where the goal was the production of the carbon). This drives off the hydrogen and light hydrocarbons (e.g., wood alcohol). These byproducts are more than sufficient to produce the energy needed for the reactions.

Furthermore, shipping the solid carbon would be more manageable than large quantities of straw.

John Kopf
Cupertino, CA

Dear sir,

I've been reading *Analog* fairly regularly since about 1960. Your recent "science fact" article was by far the worst and dumbest one I've seen. Even if the worst predictions of the global warming nuts came through, it wouldn't be half the disaster that dumping a major portion of our crop residue into the ocean would be. For one thing, it would require at least a doubling of fertilizer usage—and not just the major elements of N, P, K, and S. It would also remove vast quantities of the micro-nutrients that are essential for plant growth. It would vastly increase soil erosion—plant residue is one of the biggest factors in holding soil in place when it is attacked by wind or running water. But the biggest problem is it would destroy the soil. The biggest difference between fertile top soil and infertile sub-soil is that the top soil contains organic matter. It's true that plowing reduces organic matter, but in many parts of the country plows are history. Modern farming techniques slowly build top soil by increasing organic matter. And it's the organic matter that determines the quality of the soil. Removing all the surface matter would degrade the soil. I've lived and worked in 120 degree weather and I've missed meals—there is no question which is worse.

Robert J. Otto
Crystal, ND

Dear Dr. Schmidt,

Just a quick thought regarding "The Power of Rotting Plants" (October, 2003): As a follow-up calculation, it might be interesting to determine the volume of rotting plant mass that will pile up at the bottom of our oceans, and whether pressure and other conditions might eventually turn that biomass into oil.

Regards,
Miles Fidelman

Dear Dr Schmidt:

The numbers generated by Messrs. Metzger, Benford, and Hoffert sound wonderful . . . EXCEPT

1: How do we gather all the residue from an area equaling three states?

2: How do we transport it to the ocean?

3: How do we transport it ON the ocean to where the ocean is 4000 meters (roughly 2 and 1/2 miles) deep?

4: Once we get it to the surface above the 2 and 1/2 mile deep ocean, how do we sink it 4000 meters? Vegetation floats.

5: If we encase it to sink it, what do we encase it in? And as it forms gases, does it lighten the encasement, causing it to rise up?

6: What is the effect on deep ocean fauna, assuming that it can be sunk at all?

I could go on for another 20 or 30 questions, including energy costs for all the transport, tying up of roads, rails, and ships, (to say nothing of building all of them) and on and on into the night, but it can be summed up in three words:

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Not thought out. I expect better of the aforementioned gentlemen and of you as editor. Your masthead says "Science Fiction and Fact". If it said "Fantasy," you could say it was to done by "Magic." As it is, I'm disappointed.

Maynard J. Hirshon
Seminole, Fl.

Dear Stan,

In *Analog*'s October issue, Metzger, Benford & Hoffert ("MB&H") have committed a classic physicist's howler—lots of physics and no chemistry or biology at all ("one would have to be a chemist to [actually calculate this correctly]"), complicated by a classic "dropping of a factor of ten" (which often happens in lectures in physics), and a complete lack of common sense. As a result, their conclusion, "Burn the coal and bury the cornstalks," is wrong—it is exactly the *opposite* of the thermodynamically correct policy.

The problem —obvious to a biochemist—is that the formula for cellulose is not C6H1O5 (as written), but either C6H8O4 (for the dry polymer), or a combination, after hydrolysis and in water, of C6H10O5 and C6H12O6 for glucose, the monomer of cellulose. The error probably comes from a zero that was dropped somewhere—*before* they did their calculation—and not missed.

Any of the biologically relevant formulae puts cellulose firmly between coal and oil in terms of carbon/energy ratio. Cornstalks have little if any lignin, but that doesn't affect the calculation. The relative cost of getting the two fuels to the generator, disposing of the ash, etc. is also neglected in the MB&H analysis, although it plausibly is relevant.

So burning the cornstalks to power a generator and leaving the coal in the ground is the *more* effective policy for CO2 reduction ("other things being equal"), just as advocated by environmentalists! Gosh, how did those people ever get it right without degrees in physics? Must have been just luck . . .

Perhaps MB&H should next tackle the "Hydrogen Economy," for example including the energy needed to compress or liquefy the hydrogen so it can be put in your car (a classical physics problem, in both senses). (Hint—it's far from negligible.) Even without benefit of steam reforming, their analysis could be a real gas!

Is anyone else frightened that scientific advisors of presidents here and elsewhere—for example, the "Jasons"—are almost exclusively senior physicists, who are darwinianly selected to be true believers in one-line equations to explain the Universe—and lesser problems as well, without any reference to the methods or results of "inferior" sciences?

Francis Kirkpatrick
Chelmsford, MA

The author replies . . .

Debate is one of the most critical elements of science—key to not only furthering our understanding of the world about us, but also in addressing how to apply that science to the needs of mankind. In our article, the "Power of Rotting Plants" in the October 2003 issue, we made the observation that approximately 350 million tonnes of crop residue (containing 150 million tonnes of carbon) are annually left to rot in US fields after harvesting, resulting in the return of that carbon to the atmosphere in the form of CO_2. We asked the question, might it not be more efficient from both an energy and atmospheric carbon reduction perspective, to sequester those crop residues in the deep oceans, rather than to let them rot, or to burn them in order to generate energy? Our initial analysis indicates that there is merit to this approach.

Are all the details understood?

Absolutely not—as is to be expected at this early stage of investigation.

Many *Analog* readers raised highly relevant questions to this proposal, to some of which we can offer answers,

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while others of which point out quite rightly that before such an immense project would be undertaken that extensive experiments and cost analysis are needed. And this is exactly how it should be—we've made our proposal, illustrated the potential for reducing carbon emissions, and now need to debate the details, and make further proposals for studies and experiments to gain further insights. Many of these questions fell into broad areas:

Farming concerns—While 350 million tonnes of residues are generated, what is the environmental impact of removing the residues from the field? As we pointed out, farming techniques are rapidly evolving away from plowing residues back into the ground, in light of studies that show this actually reduces the organic content of the soil due to the disruption of microfauna. However, many other questions remain, including those of soil erosion and trace nutrient retention—where these requirements will vary from field to field. A typical crop can be viewed in roughly three equal parts—the portion harvested, the roots, and the residue. In terms of organic soil retention, the bulk of this is due to the below ground roots—and removing the residues would have minimal impact. Trace nutrients after harvesting also come primarily from roots, since the nutrients in the harvested portion of the crops are of course lost, while only a portion of those in the residues would be returned to the soil if left to rot in the fields, since much of it will also be released into the atmosphere and lost in water runoff—so while this impact needs to be considered, it is likely to be less significant than the nutrient loss due to the actual harvesting of the crop. That said, it is quite apparent that issues of erosion, nutrient retention and soil quality must be addressed in order to understand the impact and tradeoffs in the implementation of crop residue sequestering.

Economics—This topic is just as complex (possibly even more so) as the chemistry/physics of this proposal. An important aspect in favor of crop residue sequestering as compared to burning the residues to generate power is that it requires little in the way of new infrastructure to implement, since this approach uses the same land, farming equipment and transport systems needed to grow and harvest crops, while generating power through residue burning requires either the modification of existing power facilities (currently configured to burn specific fuels such as coal, oil or gas), or the manufacturing of new ones that can utilize residues as fuel. In addition, many of the costs incurred in the harvesting and transporting of crop residues for sequestering, would also be required if those residues were to be burned to generate power.

Ocean impact—As was pointed out by several readers, dried crop residues will float. Sinking them will in all likelihood require holding them in seawater for a period of time in order to become saturated (and thereby increase their density), and possible bundling with higher density wastes. This is an issue that needs to be addressed from a cost, technical, and environmental impact perspective. And of course, the behavior of these residues on the ocean floor would need to be experimentally investigated. While it is best to sink these residues as deeply as possible (to maximize diffusion times of any liberated carbon to the ocean surface), it does not require sinking to depths of many kilometers, the critical mark being that of approximately 1 kilometer at the thermocline interface, which acts as a natural boundary to intermixing between the deep and surface regions of the oceans.

Cellulose—Francis Kirkpatrick correctly pointed out that we used an incorrect chemical formula for cellulose. However, this does not alter our conclusions, or change the results of energy production as a function of carbon generation as shown in Table 1 of the arti-

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cle—the burning of crop residues to produce energy still produces significantly more carbon per unit of energy production than that of methane and oil, while a comparable amount to that of coal. Kirkpatrick proposes that we simply burn the crop residues and leave the coal in the ground. We agree that there would be merit in this, *if* those were the only two available options—however, they are not, since other fuels are available, and it is less carbon polluting and more energy efficient to burn oil or methane for power generation and sequester the crop residues. The other issue is that at the moment these crop residues are currently being left to rot—returning their carbon to the atmosphere after each harvest, unlike coal, which if left in the ground, will not return its carbon to the atmosphere. Crop residues are a valuable resource lost to us each and every year that we allow them to rot.

We are most appreciative of the keen insights and questions from the readers of *Analog*. It is our belief that an effective approach to significantly reduce carbon emissions will be one that blends multiple techniques, including the capture of emissions from power smokestacks, the migration toward more hydrogen rich fuels, generation of power from carbon-free sources (solar, wind, hydro and nuclear), along with the implementation of various sequestering approaches, of which crop residue sequestering may have an important part to play.

Robert A. Metzger ■

It's not the scarcity of money, but the scarcity of men and talents, which makes a state weak.

—Voltaire

You can't separate peace from freedom, because no one can be at peace unless he has his freedom.

—Malcolm X

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UPCOMING EVENTS Anthony Lewis

28–30 May
CONQUEST 35 (Kansas City area SF conference) at Kansas City MO. Guest of Honor: Jennifer Roberson. Fan Guests of Honor: Steve Francis & Sue Francis. Artist Guest of Honor: Jody Lee. Info: ConQuesT 35, Box 36212, Kansas City MO 64171; joyce@downing.net; www.kcsciencefiction.org/con35/htm.

28–30 May
MARCON 39 (Central Ohio SF conference) at Hyatt Regency, Columbus OH. Guest of Honor: Laurell K. Hamilton. Artist Guest of Honor: Nene Thomas. Godzilla Guest of Honor: Bob Eggleton. Costuming Guest of Honor: Julie Zettergerg. Editor Guest of Honor: Ellen Datlow. Fan Guests of Honor: Bjo & John Trimble. Filk Guests of Honor: Jane Robinson & Cynthia McQuillin. Science Guest of Honor: Hugh S. Gregory. Godzilla Special Guest: J.D. Lees. Registration: $35 until 12 May 2004, $50 at door. Info: Marcon, Box 141414, Columbus OH 43214; www.marcon.org.

28–30 May
OASIS 17 (Orlando area SF conference) at Radisson Plaza Hotel, Orlando FL. Guest of Honor: Allen Steele. Artist Guest of Honor: H. Ed Cox, Filk Guest of Honor: Michael Longcor. Special AuthorGuest: Jack McDevitt. Special Artist Guest: Rebecca Schumacher. Registration: $25 until 30 April 2004, $30 at door. Info: OASFiS, Box 592905, Orlando FL 32859-2905; (407)263-5822; jcr49@cfl.rr.com; www.oasfis.org.

28–31 May
BALTICON 38 (Baltimore area SF conference) at Wyndham Baltimore Inner Harbor Hotel, Baltimore MD. Guest of Honor: Lois McMaster Bujold. Artist Guest of Honor: Dave Seeley. Music Guest of Honor: Heather Alexander. 2003 Compton Crook Award Winner: Patricia Bray. Registration: $42 until 28 February 2004, $47 until 30 April 2004, $52 thereafter. Info: Balticon 38, Box 686, Baltimore MD 21203-0686; (410)JOE-BSFS; balticoninfo@balticon.org; www.balticon.org.

28–31 May
BAYCON 2004 (SF Bay area SF conference) at San Jose DoubleTree Hotel, San Jose CA. Guest of Honor: Michael Swanwick. Artist Guest of Honor: Jael. Fan Guest of Honor: Elayne Pelz. TM: Sean Stewart. Registration: $60 until 29 February 2004, $65 until 30 April 2004, $75 at the door. Info: Baycon, Box 610427, San Jose CA 95161-0427; (408)450-1788; info@baycon.org; www.baycon.org.

28–31 May
WISCON 28 (Wisconsin area SF conference with feminist orientation) at Concourse Hotel, Madison WI. Guests of Honor: Patricia McKillip, Eleanor Arnason. Registration: $40 until 30 April 2004, $50 at door. Info: WisCon, c/o SF3, Box 1624, Madison WI 53701; (608)233-8850; concom@sf3.org; www.sf3.org/wiscon. ■

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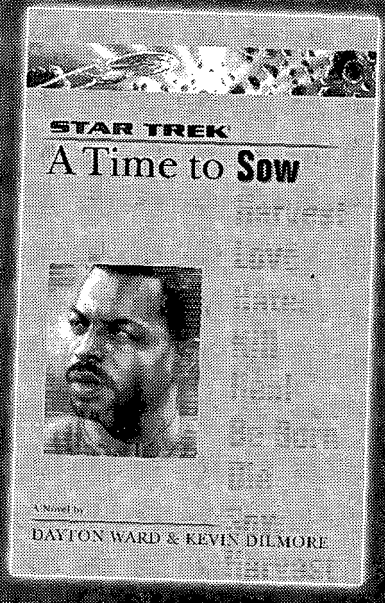

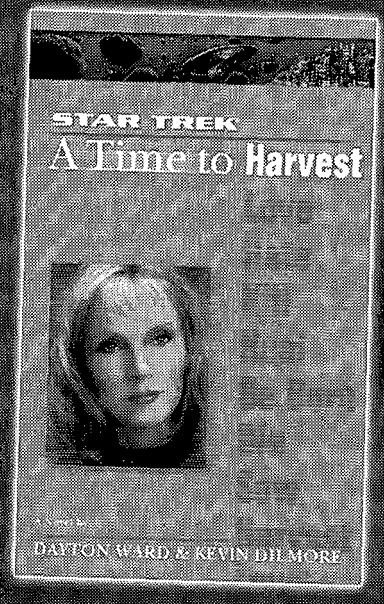

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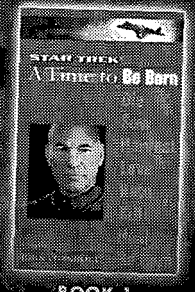

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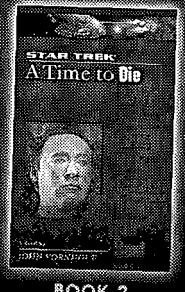

BOOK 2

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